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SCIENCE EDUCATION

THE SCIENCE MAGAZINE FOR ALL SCIENCE TEACHERS
FORMERLY GENERAL SCIENCE QUARTERLY

Summary of Investigations Regarding Unfounded Beliefs and Superstitions

Factors Affecting Achievement in Science

Extension Activities of Publicly Supported Institutions for Teachers of Science in Elementary Schools

Concomitant Learning in Human Biology

Teaching Science to Influence Behavior

The Problem of Testing

Study of Effectiveness of Student-Made and Prepared Drawings in College Biology

VOLUME 20
NUMBER 1
FEBRUARY 1936

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Science Education

Devoted to the Teaching of Science in Elementary Schools, Junior and Senior High Schools, Colleges and Teacher Training Institutions

Volume 20 FEBRUARY, 1936 Number 1

A SUMMARY OF INVESTIGATIONS REGARDING SUPERSTITIONS AND OTHER UNFOUNDED BELIEFS*

OTIS W. CALDWELL

General Secretary, American Association for the Advancement of Science

NECESSITY OF SUCH INVESTIGATIONS

If steady improvement in human reactions or behavior has the importance commonly assigned to it, there is corresponding importance attached to those attitudes which affect behavior. The causation of attitudes is extremely complex. The alleged constancy of their existence with an individual or group has not been adequately determined. No one has formulated a generally accepted list of ultimately desirable attitudes, except in terms so broad as to be less specific than needed in order to be sensed by most of us. Some encouraging progress has been made first by those who have formulated specific ways of doing things in certain science studies, and secondly by those who have reported careful investigations of certain aspects of so-called scientific methods of working. Perhaps one of the most encouraging facts is that we now hear less advocacy of scientific method as a whole, but more advocacy of some of the essential parts of a factual and scientific way of doing things. That is, we now accept many scientific attitudes, and desire that learners may gradually acquire as many of these as they can. We also accept the idea that such attitudes may be gained only by practice in them specifically. It therefore becomes clear that many related investigations are needed before we can make a mass attack upon the whole question of attitudes.

More than five years ago G. E. Lundeen and I began our studies of one aspect of the question of attitudes, namely superstitions and related unfounded beliefs.

THE GENERAL SURVEY

At the outset it was our plan to set up certain school-room experiments by which to find whether changes could be made regarding some of these ideas. The literature dealing with the question was examined and synopses were made of all available and pertinent publications. The enormous list of superstitions, and the apparently almost universal distribution of

* Presented at the meeting of the National Association for Research in Science Teaching, Atlantic City, February, 1934.

some of them, required that our first piece of work should be to determine a workable list of items. This was done by a synthesis of 200 items that recurred regularly in previously published studies. We cannot say that these 200 are the most recurrent unfounded beliefs, but can say that they are common and widely distributed. This list of 200 items was then made into a form for an inquiry regarding the exact amount of knowledge of, belief in, and influence by each of these items. The tests were given in widely separated centers, representing persons of different ages and of both sexes. The results of this study were published in two papers.[1,2] In the latter publication the entire list of 200 items is given with the calculated responses for each.

General results from this study are:

1. Each item of the 200 had been heard, believed, and had influenced some of those responding.
2. High-school seniors have heard approximately one-half the 200 items, and believe and are influenced by approximately one-fifth of those they have heard.
3. University students and members of parents associations have heard slightly more of the items than high-school students. Their percentage of belief and influence is approximately the same as for high-school students.
4. More of these items influence girls than boys, more influence women than men, and these differences hold in both rural and city communities.

Other outcomes of this phase of our work cannot be included in this brief summary.

GENERAL SCIENCE EXPERIMENTS IN CHANGING BELIEFS

Since our chief purpose was to discover ways of correcting superstitions and other unfounded beliefs, our first experiment dealt with certain items which are related to subject matter now commonly taught in the general science course. We selected items related to the unit on Health and Individual Problems, The Earth and Other Heavenly Bodies, and Weather Conditions. Four commonly used texts were studied and, wherever needful, additional text material was prepared to include not only the presentation of the topics of investigation but any other factual matter that was not included in any one of the texts. By this means the experiment could be conducted with any text the class happened to be using. Cooperating schools were secured for experimental teaching. Thirty-seven different high-school teachers cooperated in this experiment. There were 69 classes and 1799 pupils. The schools were located in 14 different states.

Pretests and post tests were prepared, covering not only the particular items of experimentation but all leading facts of the units. In the tests no separate attention was given to the experimental items.

Only the general results can be here included. They are:

1. The average knowledge gain or improvement in all the factual items of the unit including the unfounded beliefs was Unit I, 22.4%; Unit II, 30.4%; and Unit III, 21.9%.
2. The average gain in the unfounded beliefs separate from other facts of the unit are: Unit I, 33.3%; Unit II, 49.4%; Unit III, 30.2%.
3. The final test shows that no unfounded beliefs failed of some improvement following instructions.
4. Younger pupils in each class had better scores regarding unfounded beliefs in both pretests and post tests than did the older members of their respective classes.
5. So far as indicated by these experiments, it seems that knowledge of and belief in unfounded ideas is directly related to correct factual instruction.

The experimental materials and results with each item were published[3] Any member of the N.A.R.S.T. who does not have a

[1] Lundeen, Gerhard, and Caldwell, Otis W. "Study of Unfounded Beliefs Among High School Seniors." *Journal of Educational Research* 22: 257–273; November, 1930.

[2] Caldwell, O. W., and Lundeen, G. E. "Students' Attitudes Regarding Unfounded Beliefs." *Science Education* 15: 246–266; May, 1931.

[3] Caldwell, Otis W., and Lundeen, Gerhard E. *An Experimental Study of Superstitions and Other Unfounded Beliefs as Related to Certain Units of General Science.* New York: Bureau of Publications, Teachers College, Columbia University, 1932. 138 p.

copy of this monograph may secure one free by writing to the author of this paper.

BIOLOGY EXPERIMENTS WITH UNFOUNDED BELIEFS

Such false notions as the following are widely spread.

Mental disorders result from too intense study.

Children of first cousins are likely to be feeble minded.

Birthmarks are caused by frights experienced by mothers.

These and other unfounded beliefs were incorporated into an experimental teaching unit in biology. The treatment was similar to that described for the general science units. The pretests, experimental teaching and post tests were given in senior high schools in Pennsylvania to nine biology classes including 235 pupils.

The percentage of improvement in knowledge regarding the unfounded ideas ranged by classes from 22.3% to 47.1% with a pupil average of 32.9%. The improvement in factual items other than those related to unfounded beliefs ranged by classes from 19.6% to 29.7%, with a pupil average of 23.1%.

This experiment was published[4] and reprints are available to those who wish them.

IS THERE ANY CHANGE IN BELIEF IN SUPERSTITIONS BETWEEN 7TH, 8TH AND 9TH GRADES IN JUNIOR HIGH SCHOOL?

This question had often been raised during progress of our investigations. We secured the cooperation of the superintendent and principal in a large junior high school in New Rochelle, N. Y. Mr. Lundeen and I prepared a test which we called the Opinion Ballot. This consisted of 200 items, fifty of which were correct and 150 incorrect. This test was given to 854 pupils fairly well distributed between seventh, eighth, and ninth grades, also well distributed between the sexes. The test sought to learn the percentage of items believed by each pupil. The test was given near the close of the school year, the pupils thus having had almost the full year of instruction of the grade in which they were listed.

The results show that erroneous belief exists as follows:

	Mean
Seventh Grade	35.01 items
Eighth Grade	22.54 items
Ninth Grade	20.09 items

The belief recorded for each item ranged from zero in three of the 200 items, to 69 for the item believed by the largest number.

Again the girls regularly believed more of the false items than did the boys. Also, the younger pupils in a class believed fewer false items than did the older pupils in the same class.

A significant difference was found between seventh and eighth grade pupils, and a small difference between eighth and ninth grade pupils. Inferences from this investigation indicate a distinct reduction in acceptance of superstitious beliefs as pupils advance through the junior high school. The fact that almost all this gain is recorded by the eighth grade as compared with the seventh, leaves doubts as to the proper explanation of why the ninth grade shows almost no gain over the eighth grade. The fact that in the ninth grade 51 of the 200 items had lower scores than in the eighth grade, makes further tests desirable.

There is a continuous program of science instruction in the school tested. It has not been specifically proved, but seems likely, that there is a causal relation between this science instruction and the reduction in acceptance of unfounded beliefs. The results of this study were published in 1934.[5] (Reprints are available upon request.)

[4] Caldwell, Otis W., and Lundeen, Gerhard E. "Changing Unfounded Beliefs—A Unit in Biology." *School Science and Mathematics* 33: 394–413; April, 1933.

[5] Caldwell, O. W., and Lundeen, Gerhard E. "Further Study of Unfounded Beliefs Among Junior High School Pupils." *Teachers College Record* 36: 35–52; October, 1934.

A popular volume has been prepared, designed to stimulate thinking about attitudes. This volume called *Do You Believe It?* presents the origin and nature of influence of many common superstitions and other unfounded beliefs. This volume includes many items and investigations not published elsewhere. An extensive but selected bibliography is included. Also there are presented samples of ways in which anyone may secure facts by means of which to test his beliefs. As an example I may cite the superstition about St. Swithin's day.

The weather on July 15, St. Swithin's day, is said to be a key to the kind of weather that will be had in the next 40 days. St. Swithin was a bishop in Winchester, England. How good a man he really was, seems not to have become recognized until about 100 years after his death. It was then decided that he should be canonized and his body was ordered transferred from its humble burial place to a shrine in the Cathedral. But when the exhumation began, rain started, and for 40 consecutive days rainy weather delayed the transfer. Hence the St. Swithin legend.

What are the facts? (see page 176 and 177 of *Do You Believe It?*.) Mr. Lundeen and I used this as one of several samples of the potency of facts as compared with foolish fancy. We secured the authentic United States weather reports from eight cities, widely separated, in which it rained on July 15, 1933, and of eight cities in which it did not rain on July 15, 1933. We secured the complete records of these 16 cities for 40 days beginning with July 15, 1933. In the eight cities without rain on July 15, there were an average of $16\frac{5}{8}$ days on which it rained during the following 40 days. In those eight cities having rain on July 15, there was an average of $19\frac{7}{8}$ of the following 40 days when it rained, and this second list included Wilmington, N. C., which had 33 rainy days.

In all this study of attitudes facts are highly desired and will prove potent. This committee on attitudes and the whole N.A.R.S.T. can do a good service by stimulating researches in separate aspects of the whole question, then from time to time coordinating and assaying these researches. Those who write materials for pupil use can help by including the results already secured so that immediate attack may be made so far as that is guided by proved methods.

WHAT FACTORS MAKE FOR GOOD OR POOR ACHIEVEMENT IN SCIENCE?*

A. W. Hurd

Northern Montana College, Havre, Montana

Why is it that some pupils do well and others do poorly in school work? A common reply is that some pupils apply themselves and others do not. The question is, however, much more complicated. Would all pupils be able to make satisfactory achievement in all school courses if they diligently applied themselves? Why do some pupils not apply themselves? What effect has interest on achievement? What effect has a pupil's extra-curricular activities on his school achievement? What effect has his natural mental capacity on his achievement? What effects do desirable character traits have on achievement?

Proponents of the scientific method like to get objective data on questions like these. They have learned from experience that it is not safe to rely on unsupported opinion. We cannot be sure of our judgments on these kinds of questions. The wise thing to do before giving answers is to investigate. In carrying on some experimentation with an instructional unit in science, "Sound Music and Hearing," the

* Given at the Atlantic City meeting of the N. A. R. S. T., Monday, Feb. 25, 1935.

speaker attempted to get data which would help him give correct answers to some of the above questions. Test scores from preliminary and final tests with total possible values of 119 points on each form were available from the experiment. There was definite statistical evidence proving the reliability and validity of the tests. The two tests were equivalent. Conventional achievement in this experimentation was represented by the per cent of possible gain made by pupils from preliminary to final test. This is probably a better measure of achievement than either the final score or the gain in scores. To get the per cent of possible gain, the difference was found between final and preliminary scores for each individual and divided by the difference between his total possible score and his preliminary score. This was expressed in per cent.

A questionnaire and other specially recorded data supplied information used in the various comparisons made. As the experiment was conducted in more than twenty schools, comparisons between pupil groups were always made so as to counterbalance the influence which a given school might exert on the scores. This was done by matching every pupil in one criterion by a pupil from the same class in the same school so that excellence would not be due to the preponderance of individuals from a given class or school. In making group comparisons the difference between mean percentages of possible score gains for the compared groups were divided by the standard errors of these differences in order to get critical ratios. A critical ratio of 3.00 or more indicates practical certainty of a true difference.

The following are the obtained findings:

1. The data favored those liking the subject of physics quite well. The critical ratio between those liking it quite well (rating of 1) and those liking it (rating of 2) is 2.86. There is little difference in achievement between groups liking it (rating of 2) and those neither liking nor disliking it (rating of 3). Those rating it 4 or 5 (disliking it and disliking it very much, respectively,) are lowest of all in achievement. The interpretation of these data is that, on the average, pupils having a great liking for physics make higher achievement ratings in this unit on, "Sound, Hearing, and Music." This finding is probably in accordance with general opinion on the subject. It seems logical to think that interest makes for achievement and the data for this unit support the opinion.

2. The same conclusion is borne out with expressed liking for general science. The critical ratio showing the comparison between those liking general science and those neither liking nor disliking it is 3.00. There is a continuous falling off of achievement below an interest rating of 2 (liking it).

3. There is a similar tendency for high achievement in this unit to accompany liking for chemistry also but it is not so marked.

4. There is a distinct tendency for high achievement to accompany liking for algebra. The critical ratio comparing groups rating it 1 or 2 and groups rating it 4 or 5 is 4.49.

5. It is interesting to note that there is no such difference in achievement for any comparison between those liking, in various degrees, reading about machinery, reading about electricity, or reading about inventions. The absence of differences in these types of interests is evidence of the validities of the differences obtained in the former comparisons.

6. Liking for study seems to be attended by higher achievement scores. The critical ratio between a liking rating of 1, and those of 4 and 5 combined, for this unit is 2.91.

7. Those reporting fewer hours of recreation per day seem to make higher achievement scores. The critical ratio between scores for persons reporting 0 hours and those reporting 4.00 to 4.90 hours of recreation is 2.34.

8. Achievement scores are higher for those belonging to four clubs when com-

pared with those belonging to 0 clubs. The critical ratio is 3.24. This is interesting. One might think that belonging to clubs would lower achievement scores, but the evidence shows the contrary.

9. Achievement scores are higher for those groups having higher I.Q.'s. Critical ratios favor higher I.Q.'s. all along the line by difference of 10 points in I.Q. when comparisons are made from below an I.Q. of 100 to one above 130. Critical ratios are as follows: those below 100 compared with those between 100 and 109—2.97; those between 100 and 109 compared with those between 110 and 119—3.10; those between 110 and 119 compared with those between 120 and 129—3.13. Above 130 there is a sharp drop in achievement but it is still higher for those groups than for those below an I.Q. of 120.

10. Those reporting no help in class work apparently have higher achievement scores than those receiving help. The critical ratio is 2.29. This indicates that self-reliant pupils tend to make higher achievement scores.

11. Data favor those who say that they think health affects their work. The critical ratio between those who say that it affects their work much and those who say it affects their work little is 2.04. This may imply that, on the average, pupils who think their health affects their work are more careful, thoughtful, and painstaking than those who say that their health does not affect their work.

12. Data favor those who sleep 9 or 10 hours a night over those who report 7 or fewer hours. The critical ratio is 2.43. This is in keeping with the preceding statement. Perhaps those who take care that they have sufficient sleep also take care that they do good school work.

13. Data favor those who report pulse rates between 70 and 80 compared with those who report rates lower than 70 (critical ratio—2.15); and also compared with those who report rates above 80 (critical ratio—1.05). While this may have considerable physical significance, there is a chance that pupils who do not count correctly are those who do poor school work. Owing to the method used we cannot be sure that pupils counted their pulse rates correctly.

14. Data favor those who come from families of six or more compared with those who report three or less (one child). The critical ratio is 1.91.

15. Data favor those receiving high ratings in certain traits including originality, industry, systematization, and consciousness. Critical ratios comparing those averaging above 6 points on a ten-point scale and those averaging less than 6 points is 5.97.

16. Data favor boys over girls. The critical ratio comparing groups of boys and girls matched on the bases of age, grade, and instructor is 3.06.

17. Data favor 12th grade over 11th grade pupils. The critical ratio comparing groups of 11th and 12th grade pupils matched on the bases of age-grade (12th grade pupils being one year older), instructor, and preliminary test scores is 3.59.

Twenty-three other comparisons made show smaller differences between groups compared. An examination of all comparisons, additional studies of the 28 highest and 28 lowest pupils enrolled for the experiment in all schools, and case studies of the highest and lowest pupil, respectively, make a more accurate judgment of factors conditioning achievement in science work possible. A dynamic attitude on the part of the pupil, an interest in the kind of work represented, both constituting motivation; a good teacher; natural mental ability sufficient for the work; the possession of character trait ratings above the average on such traits as originality, industry, self-reliance, systematization, and consciousness; all of these make for high achievement on the instructional unit used in this experimentation. Further investigation with other instructional units and with other

possible conditioning factors will help us to give more complete answers to problems involving the causes for good or poor achievement.

THE EXTENSION ACTIVITIES OF CERTAIN PUBLICLY SUPPORTED INSTITUTIONS IN ASSISTING TEACHERS IN SERVICE IN ELEMENTARY SCIENCE OR NATURE STUDY*

LEO FRANKLIN HADSALL

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SCOPE OF THE STUDY

This study includes a critical analysis of the various types of extension agencies developed by publicly supported institutions for the purpose of assisting teachers in service in elementary science or nature study.

It reviews the causal factors associated with the development of the aforementioned agencies and the manner in which such agencies have been financed.

It aims to establish within specific limits the geographical areas served by the aforementioned agencies; the number of individuals reached; and the period of service.

It considers the effectiveness of the *Cornell Rural School Leaflet* and the extramural nature study classes conducted by the Pennsylvania State College in assisting teachers in service.

LIMITATIONS OF THE PRESENT STUDY

This study is confined to analyses of extension agencies developed for the purpose of assisting teachers in elementary science or nature study by Cornell University; University of Chicago; Teachers College, Columbia University; the accredited colleges and universities of Pennsylvania; and the Fresno and San Jose (California) State Teachers Colleges.

It considers only those extension agencies which are directly related to teachers in service, excluding such activities as 4H Clubs and correspondence courses in agriculture.

It does not attempt to evaluate the topics treated in the publications considered. It does not draw conclusions relative to specific extramural science or nature study courses listed. It does not include as extramural activities those campus or off-campus activities for which residence credit was granted.

METHODS USED IN SECURING DATA

Data utilized in this study were secured through

1. *Personal interviews* with elementary teachers; elementary supervisors; the Director of the Pennsylvania Teacher Bureau; and the directors of extension services at Cornell University, Pennsylvania State College, University of Chicago, University of Iowa, Bucknell University, and the Fresno and San Jose (California) State Teachers Colleges.

2. *Examination of extension records* of the accredited colleges and universities of Pennsylvania; Cornell University; University of Chicago; Teachers College, Columbia University; and the Fresno and San Jose (California) State Teachers Colleges.

3. *Administration of questionnaires* to teachers in service; elementary supervisors; and specialists in elementary education.

SYNOPSIS OF SUMMARY AND CONCLUSIONS

1. *Types of Extension Agencies.* Extension agencies created by publicly supported institutions to assist teachers in service in elementary science or nature study include publications; extramural classes;

* Abstract of a thesis presented to the faculty of the Graduate School of Cornell University in partial fulfillment of the requirements for the degree of doctor of philosophy.

correspondence courses; Junior Naturalist and Junior Gardeners Clubs; personal visitation; teachers institute service; visual aids; and radio. Of these, publications, extramural classes, and correspondence instruction have included the major portion of the activities developed. The nature study publications include those prepared especially for teachers; those prepared especially for children, and those prepared for both teachers and children.

2. *Causal Factors Associated with the Development of Nature Study or Elementary Science Extension Agencies.* The following may be regarded as powerful factors contributing to the development of nature study or elementary science extension agencies by the institutions included in this study:

a. The Country Life Movement. The Cornell nature movement, in the beginning a part of the Country Life Movement, had as its original objective the development of the interest of farm children in their natural environment and thereby their retention on the farm. It is doubtful that such an objective was well chosen. Many of the farm lands of New York State have been well abandoned.

b. Institutional desire to serve, personal interest of faculty members, combined with requests for assistance from teachers in service.

c. Lack of trained teachers and modification of state certification requirements.

d. Demands of conservation leaders.

e. Selfish motives.

3. *Support of Nature Study or Elementary Science Extension Agencies.* The support of the extension agencies considered in this study has rested on one or a combination of (a) allocation of state funds for extension work; (b) subscriptions by individuals or school districts; and (c) fees contributed by individuals or school districts.

4. *Scope of Nature Study or Elementary Science Extension Agencies.* The major work in the field of publications has been executed by Cornell University. Their program was inaugurated in 1896 and has continued without interruption but with various modifications to the present (1934). The *Cornell Rural School Leaflet,* inaugurated in 1907, has proven the most permanent of the various nature study extension activities developed to date. During the school year, 1930–1931, approximately 20,000 rural New York teachers and 115,000 rural New York children were regularly reached by the *Cornell Rural School Leaflet* service. The Fresno and San Jose (California) State Teachers Colleges undertook publication services subsequent to September, 1926.

Extramural classes in science and nature study constituted an essential part of the extension activities of the normal schools, colleges and universities of Pennsylvania subsequent to the enactment of the Edmonds Act in 1921.

Correspondence instruction in science and nature study has been effectively carried on by Cornell University; the University of Chicago; and the Pennsylvania State College.

Junior Naturalist and Junior Gardeners Clubs were developed by representatives of Cornell University, 1898–1907.

Personal visitation and teachers institute service have been regularly practiced by representatives of Cornell University and Pennsylvania State College.

Visual aids in the form of film strips on west coast nature subjects have been prepared by the San Jose (California) State Teachers College.

The university radio station has been regularly utilized by representatives of Cornell University for assisting teachers in nature study since September, 1931.

5. *Evaluation of Nature Study Publications.* Rural New York teachers in service, New York district superintendents, and leaders in elementary education cooperated in evaluating the usefulness of the childrens' numbers of the *Cornell Rural School Leaflet.* They approved the follow-

ing items as worthy of serious consideration when preparing nature study publications for children: (a) the selection of important problems of special interest to children; (b) the selection of problems which can be treated effectively by those preparing the bulletins with primary consideration to local materials; (c) using language within the comprehension of elementary school children; (d) size and spacing of print; (e) size, type and frequency of illustrations; (f) quality of paper; (g) inclusion of sample lessons or specific grade activities; (h) suggesting devices for presenting nature study; (i) suggesting methods for the care and collecting of materials; and (j) preparing the material from the point of view of children rather than adults.

RECOMMENDATIONS

1. *Publications.*

a. *Cornell Rural School Leaflet.*

The use of language within the comprehension of a sixth-grade child in each of the childrens' numbers is recommended as a desirable way of increasing the value of the leaflet service.

More checking on the use of the leaflets by New York district superintendents would contribute to greater effectiveness.

More adequate library facilities are necessary for the proper care of the leaflets in the rural schools visited.

Adequate funds must be allotted for its maintenance if the service is to be continued unimpaired. Fewer copies of this publication were issued and distributed during the school year, 1932–1933, than during any similar period since 1920. This was a direct result of restriction of funds allotted for publication costs. There has been no decrease in the demand for the leaflets on the part of teachers in service.

There is a felt need for the leaflet service in urban areas. The scope of distribution, supported by state appropriations, might well be expanded to serve rural and urban areas alike. Restriction in the number of copies to each school would make it possible to serve a larger number of schools with little additional expense.

Some method of distributing the leaflets should be instituted so that all eligible schools are regularly served with both teachers' and children's numbers. Most of the teachers who fail to apply for the children's leaflets are new teachers. A partial solution might be reached through more emphasis on the use of the leaflet service by normal school teacher training and science instructors, combined with personal instruction annually in each of the New York state normal schools by representatives of the leaflet service.

b. *The monthly Nature Study Bulletin* issued by Fresno (California) State Teachers College was decidedly limited in its distribution. The area of service could have been greatly enlarged by formal advertising and revision of the closely printed pages which created the undesirable effect of hardness.

c. *Western Nature Study,* a quarterly publication, issued by San Jose (California) State Teachers College, quickly assumed such large size that it became too costly for most rural teachers and found its support in urban areas. To be most effective and reach a large number of teachers in service, nature study publications should be comparatively small in size; issued frequently, on time; and distributed on a low cost basis.

2. *Extramural Classes.* The extramural nature study and science class activities of the normal schools and accredited colleges and universities of Pennsylvania, 1921–1932, should not be regarded as wholly typical of the best extramural class activity in these fields. This may be attributed to the suddenly increased state certification requirements handed down by the State Department of Public Instruction, which teachers in service were compelled to meet as best they could, rather than the failure of most institutions to extend their services. In many cases the required credits necessary for certification were the impelling

force rather than personal desire. Teachers in service were also frequently limited in their choice of courses to those few which were offered in their immediate vicinity. The best extramural class instruction is likely to be executed when a local group makes a voluntary choice from a wide range of offerings, and the specific course chosen is organized to meet the needs of the local group.

It is evident that extramural nature study classes did not function effectively in reaching the rural areas of Pennsylvania. Eighty-eight per cent of the 3953 students enrolled in extramural nature study courses conducted by Pennsylvania State College attended classes in extramural centers having a population over 10,000. Only in so far as the urban centers were accessible to rural teachers were they able to take advantage of extramural nature study class offerings. A small, frequent nature study publication might well supplement the previous extramural nature study class activities in urban areas and render assistance to rural teachers.

The enrolment in extramural nature study classes should be limited. Decidedly less nature study was taught in the extramural center where the extramural nature study classes had three times the mean enrolment of all nature study classes conducted by Pennsylvania State College, 1923–1932, than in those centers where the mean enrolment was more nearly approximated. Large classes obviate purposeful field work which should constitute an essential part of extramural nature study class activities.

3. *Correspondence Courses.* The criticism that correspondence instruction lacks the personal touch of resident or extramural class instruction can be partially alleviated by having each student come, in so far as feasible, to the college for a personal interview with the instructor at some period during the conduct of the course.

Some minimum time limits should be established for the completion of correspondence courses for credit. This would tend to offset the powerful stimulus of state certification requirements which tends to result in the search for readily available credits.

4. *Clubs.* The need for nature clubs sponsored by publicly supported institutions has largely disappeared. The scout organizations, 4H Clubs, and Audubon Society satisfactorily fulfill the need for this type of activity.

5. *Personal Visitation.* Personal visitation should be practiced whenever feasible to supplement less costly and more ambitious forms of extension activities. This is probably the most effective form of extension activity within the area covered but is limited by the amount of time which an instructor can devote to the individual teacher and the high cost of this form of service.

Personal visitation to areas served should be practiced in so far as time will permit by individuals preparing nature publications for distribution among teachers in service. This affords a personal check on the effectiveness of the materials prepared and uncovers problems pertinent to this field of service .

6. *Teachers Institute Service.* Teachers institute service affords opportunity for personal contacts with large numbers of teachers. Among the institutions included in this study, this form of nature study extension service has been practiced to the greatest extent by representatives of Cornell University. The teachers institutes have gradually fallen into disrepute in certain sections of America. This may signify weaknesses in the types of programs presented rather than that this form of educational service is unsound.

7. *Visual Aids.* Visual aids in the form of "Nature Study Illustrated," a film strip service, was created by representatives of San Jose (California) State Teachers College to meet a definite need for useful illustrations of west coast biological phenomena. The same need is well supplied in the east-

ern United States by reliable commercial houses.

8. *Radio.* The use of the radio must be regarded as in an experimental stage as a medium for assisting teachers in service in nature study. Experiments might well be conducted to determine the best types of nature study programs and to test their effectiveness as a means of familiarizing children with the natural phenomena about them.

9. *Ideal Nature Study or Elementary Science Extension Program.* The most effective extension program probably consists of a combination of two or more extension agencies. Extension classes and personal visitation afford personal contacts which cannot normally be approached through the media of publications, correspondence courses and radio. On the other hand, they fail to penetrate the isolated sections where they may be most needed. Extension classes, correspondence instruction and personal visitation are relatively expensive agencies in terms of individuals reached, and are less likely to prove permanent. Nature publications afford a more permanent means of assisting teachers in service than the other forms of extension agencies thus far developed. To be most effective a publication extension program should supplement or accompany some more personal form of extension service such as extramural classes, group conferences, or personal visitation and supervision.

10. *Further Studies.* Further studies might well be concerned with determining the most desirable content to be treated by nature study extension agencies.

CONCOMITANT LEARNING IN HUMAN BIOLOGY

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THE NATURE OF THE INVESTIGATION

This study deals with the examination of a body of data collected in a course in Human Biology taken by students in the General College at the University of Minnesota during the Spring Quarter, 1933–1934.* The purpose of the investigation was to obtain a measure of some of the outcomes other than specific learning, which might grow out of a course in Human Biology. For this determination an examination was given previous and subsequent to instruction, an interval of three months. The examination was made up of 100 true-false statements of common beliefs regarding health and disease, supplemented by a considerable number of statements of claims made relative to the effectiveness of certain home remedies or commercial preparations. The examination was validated by securing the independent judgments of three authorities in the fields of physiology and medicine relative to the scientific evidence now available, upon which might be based the truth or falsity of a given statement. No statement was introduced into the examination upon which there was not unanimous agreement on the part of the judges. In addition, a graduate student, trained in the field of physiology and medicine attended all class meetings and kept a complete record of the materials presented. No statements identical with materials given in the lectures or in other materials of instruction were introduced. An analysis was made, as well, of the content of other courses taken concurrently by the students to note that the materials in the examination had not been given in such sources. It may be pointed out here that an additional control resulting from the ad-

* Acknowledgment is made here to the University Committee on Educational Research under whose auspices the investigation was conducted and to Dr. Wm. A. O'Brien, instructor in the course, and Dr. Malcolm S. MacLean, director of the General College, for their generous cooperation.

TABLE 1
CASE I

No.	*Groups* $h=5$	x *Mid.-pt.*	*Arbitrary Unit* U	f_1	f_1U_1	$f_1U_1^2$	$f_1U_1^3$	$f_1U_1^4$
1	0–	2.4995	–6	12	–72	432	–2592	15552
2	5–	7.4995	–5	5	–25	125	– 625	3125
3	10–		–4	7	–28	112	– 448	1792
4	15–		–3	12	–36	108	– 324	972
5	20–		–2	12	–24	48	– 96	192
6	25–		–1	5	– 5	5	– 5	5
7	30–	32.4995	0	15	0	0	0	0
8	35–		1	17	17	17	17	17
9	40–		2	14	28	56	112	224
10	45–		3	17	51	153	459	1377
11	50–		4	8	32	128	512	2048
12	55–		5	9	45	225	1125	5625
13	60–		6	3	18	108	648	3888
14	65–		7	5	35	245	1715	12005
15	70–		8	0	0	0	0	0
16	75–	77.4995	9	1	9	81	729	6561
17	80–85	82.4995	10	0	0	0	0	0
Total				142	45	1843	1227	53383

$\mu_1^1 = 0.31590$ $\quad \overline{X} = 34.0790$ $\quad \sigma_x^2 = 319.89111025$ $\quad \sigma_x = 17.8855$

$\mu_2^1 = 12.9789$ $\quad (\mu_1^1)^2 = 0.0997928$ $\quad \mu_3^1\mu_2^1 = 2.729629$

$\mu_3^1 = 8.6408$ $\quad (\mu_1^1)^3 = 0.0315245$ $\quad \mu_2^1(\mu_1^1)^2 = 1.295201$

$\mu_4^1 = 375.9366$ $\quad (\mu_1^1)^4 = 0.0099586$ $\quad \mu_3^1\mu_1^1 = 4.100035$

TABLE 2
CASE II

No.	*Groups* $h=5$	x *Mid-pt.*	*Arbitrary Unit* U	f_1	f_1U_1	$f_1U_1^2$	$f_1U_1^3$	$f_1U_1^4$
1	0–	2.4995						
2	5–	7.4995						
3	10–		–7	3	–21	147	–1029	7203
4	15–		–6	1	–6	36	–216	1296
5	20–		–5	4	–20	100	–500	2500
6	25–		–4	10	–40	160	–640	2560
7	30–		–3	15	–45	135	–405	1215
8	35–		–2	10	–20	40	–80	160
9	40–		–1	14	–14	14	–14	14
10	45–	47.4995	0	21	0	0	0	0
11	50–		1	17	17	17	17	17
12	55–		2	10	20	40	80	160
13	60–		3	17	51	153	459	1377
14	65–		4	10	40	160	640	2560
15	70–		5	8	40	200	1000	5000
16	75–	77.4995	6	0	0	0	0	0
17	80–85	82.4995	7	2	14	98	686	4802
Total				142	16	1300	–2	28864

$\mu_1^1 = .112676$ $\quad \overline{x} = 47.6012$ $\quad \sigma_x^2 = 228.55575$ $\quad \sigma_x = 15.118$

$\mu_2^1 = 9.15493$ $\quad (\mu_1^1)^3 = .01269588$ $\quad \mu_3^1\mu_2^1 = -.001586478$

$\mu_3^1 = -.01408$ $\quad (\mu_1^1)^3 = .00143052$ $\quad \mu_2^1(\mu_1^1)^2 = .1162299$

$\mu_4^1 = 203.267606$ $\quad (\mu_1^1)^4 = .0001612$ $\quad \mu_3^1(\mu_1^1) = -.00158648$

ministration of the same examination to a group of similar students not pursuing the course in Human Biology was not obtained at the time of the investigation. The reliability of the examination was: $r = .85 \pm .01$.

A few illustrations of the test items selected at random are:

1. The majority of people troubled with obesity have glandular disorders which can be cured by medicines.
2. A mother has a prenatal influence on an expected child.
3. Boils are an indication that the blood is purifying itself from within.
4. The eating of red meat causes high blood pressure.
5. Many patent medicines owe what success they may have to their high alcoholic content.
6. When the oldest inhabitant begins to feel a change in his joints, there is going to be a change in the weather.
7. A congenital disease is inherited.
8. A person with an amputated limb can feel cramps and pains in the missing member.
9. There is little, if any, relationship between a pain in the lumbar region and diseases of the kidney.
10. The growing pains of childhood are due to a too rapid growth of the body.

ANALYSIS OF THE DATA

The problem involves a comparison of the types of distribution of scores on the initial and terminal examination and the significance of the differences between the mean values and variances of the two. For the reader who may be somewhat unfamiliar with the processes employed, a rather complete presentation is given of the computations involved in the reduction of the data.

A. CURVE FITTING AND TESTING

Table 1 shows the distribution of scores on the initial examination and the computations of the four successive moments about the origin; Table 2 does the same for the scores on the terminal examination. The former is designated as Case I; the latter, as Case II.

Following are the computations for the moments about the mean:

CASE I

$\mu_2 = \mu_2' - (\mu_1')^2 = 12.8791$

(μ_2) corrected $= 12.7958$

$\mu_3 = \mu_3' - 3\mu_1'\mu_2' + 2(\mu_1')^3 = -3.5963$

(μ_3) corrected $= -3.5963$

$\mu_4 = \mu_4' - 4\mu_1'\mu_3' + 6(\mu_1')^2(\mu_2') - 3(\mu_1')^4 = 372.7594$

(μ_4) corrected $= \mu_4 - \frac{\mu_2}{2} + 7/240 = 366.3907$

$\beta_1 = \frac{\mu_3^2}{\mu_2^3} = \frac{-12.9334}{2095.088} = 0.00617$

$\sqrt{\beta_1} = 0.07855$

$\beta_2 = \frac{\mu_4}{\mu_2^2} = \frac{366.3907}{163.7325} = 2.2377$

Pearson's Type II Curve; definitely platykurtic.

CASE II

$\mu_2 = \mu_2' - (\mu_1')^2 = 9.14224$

(μ_2) corrected $= 9.05891$

$\mu_3 = \mu_3' - 3\mu_2'\mu_1' + 2(\mu_1')^3 = -3.10584$

(μ_3) corrected $= -3.10584$

$\mu_4 = \mu_4' - 4\mu_3'\mu_1' + 6(\mu_1')(\mu_2') - 3(\mu_1')^4 = 203.97085$

(μ_4) corrected $= \mu_4 - \frac{\mu_2}{2} + 7/240 = 199.42887$

$\beta_1 = \frac{\mu_3^2}{\mu_2^3} = .0129757 \qquad \sqrt{\beta_1} = .1139$

$\beta_2 = \frac{\mu_4}{\mu_2^2} = \frac{199.42887}{75.90591} = 2.4301$

Apparently Pearson's Type II Curve; somewhat platykurtic; but normal curve is tried to test for goodness of fit.

Equation of Pearson's Type II Curve:

$$y = y_0 \left(1 - \frac{x^2}{a^2}\right)^m$$

$$a^2 = \frac{2\beta_2\sigma^2}{3 - \beta_2}$$

$$-a \leq x \leq a$$

$$m = \frac{5\beta_2 - 9}{2(3-\beta_2)}$$

$$y_0 = \frac{1}{a}\,\frac{\Gamma(m+3/2)}{\sqrt{\pi}\,\Gamma(m+1)}$$

CASE I:

$\beta_2 = 2.2377$

$\sigma^2 = (12.7958)(25)$

Whence

$$a^2 = \frac{4.4754}{0.7623}(12.7958)(25) = 1878.0775$$

$a = 43.3370$

$\log N\, y_0 = 0.438012$

$$m = \frac{2.1885}{1.5246} = 1.4355$$

CASE II:

$\beta_2 = 2.4301$

$\sigma^2 = 9.05891\ (25) = 226.47275$

Whence,

$$a^2 = \frac{4.8602\ (9.05891)\ (25)}{0.5699} = 1931.3965$$

$a = 43.948$

$\log N\, y_0 = 0.28564$

$$m = \frac{3.1505}{1.1398} = 2.7639$$

ORDINATES FOR NORMAL CURVE

CASE I

σ	$\frac{x-\bar{x}}{\sigma}$	$\frac{Nh}{\sigma}(z)$
3σ		
$5/2\sigma$		
2σ	–1.6920	2.14
$3/2\sigma$	7.2506	5.14
σ	16.1934	9.61
$\sigma/2$	25.1362	13.98
$\bar{x}$	34.0790	15.84
$\sigma/2$	43.0218	13.98
σ	51.9646	9.61
$3/2\sigma$	60.9074	5.14
2σ	69.8502	2.14
$5/2\sigma$	78.7930	0.70

Hence, values of $\sqrt{\beta_1}$ for these samples would lead one to believe that they were drawn at random from a normal population.

Test for β_2:

For N = 150 (lower limits).

1% limit	5% limit
2.29	2.45

CASE I

Pearson's Type II Curve:

$$\frac{1}{a^2} = 0.000532439 \qquad y = y_0\left(1-\frac{x^2}{a^2}\right)^m$$

$$\log y = \log y_0 + m \log\left(1-\frac{x^2}{a^2}\right)$$

1×1	x^2/a^2	$m\log\left(1-\frac{x^2}{a^2}\right)$	$\log y + \log(h)$	$(h)\,y$
31.5795	0.531003	$\bar{1}.527965$	0.664947	4.62
26.5795	0.376166	$\bar{1}.705822$	0.842804	6.96
21.5795	0.247953	$\bar{1}.822350$	0.959332	9.11
16.5795	0.146362	$\bar{1}.901344$	1.038326	10.92
11.5795	0.071395	$\bar{1}.953822$	1.090804	12.33
6.5795	0.023050	$\bar{1}.985462$	1.122444	13.26
1.5795	0.001328	$\bar{1}.999172$	1.136154	13.68
3.4205	0.006230	$\bar{1}.996104$	1.133086	13.59
8.4205	0.037754	$\bar{1}.976007$	1.112989	12.97
13.4205	0.095901	$\bar{1}.937148$	1.074130	11.86
18.4205	0.180671	$\bar{1}.875770$	1.012752	10.30
23.4205	0.292064	$\bar{1}.784666$	0.921648	8.35
28.4205	0.430080	$\bar{1}.649471$	0.786453	6.12
33.4205	0.594719	$\bar{1}.436934$	0.573916	3.75
38.4205	0.785981	$\bar{1}.038864$	0.175846	1.50
43.4205	Below			
48.4205	axis			

Conclusions.—Tables for Statisticians, Part II, p. 224.

For N = 150

Test for $\sqrt{\beta_1}$:

5% limit	1% limit
0.321	0.464

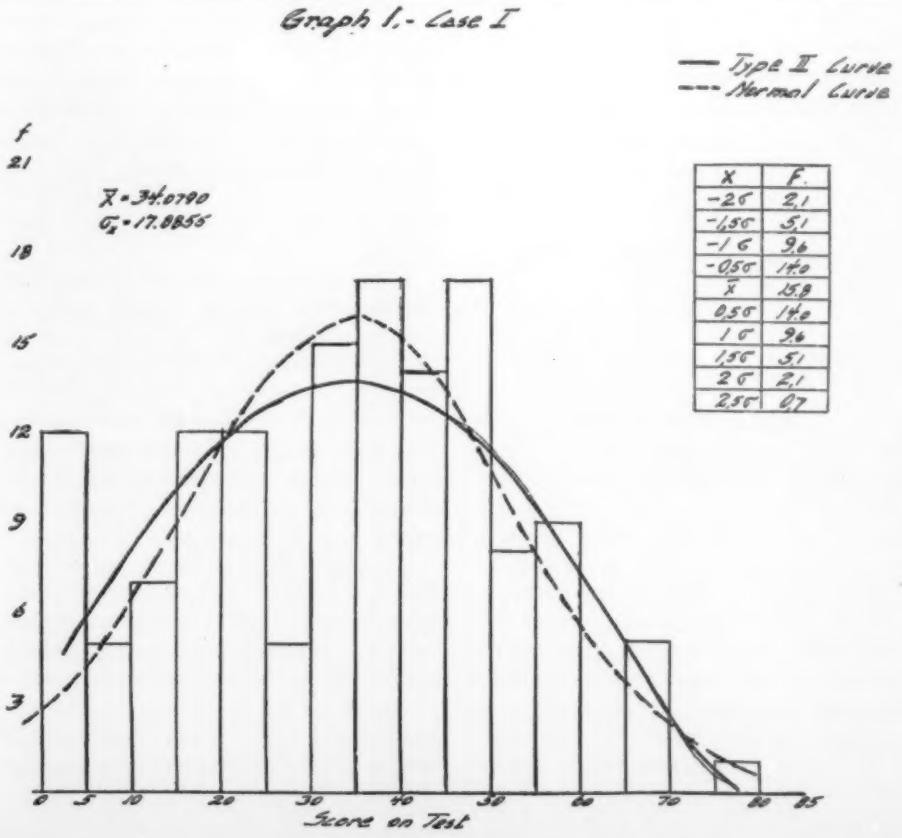
Case I. Here β_2 lies outside the 1% limit so this sample could not be considered as a random sample from a normal population. (See Graph 1); Type II is the best fitting curve.

Case II. Here β_2 lies very near the 5% limit so this sample might be considered as a random sample from a normal population. The application of the Chi-square test gives: $P < .25$. Hence only a normal curve was used here. (See Graph 2.)

CASE II

FITTING THE NORMAL CURVE TO THE DISTRIBUTION

Freq.	Intervals	X	$W=\frac{x-\bar{x}}{\sigma}$	Area from Mean	Area in Groups	N_t Expected	Z	$Y=Z\frac{N}{\sigma}$
2	80–85	37.3988	2.47	.4932	.0094	1.3348	.0189	.8875
0	75–80	32.3988	2.14	.4838	.0189	2.6838	.0404	1.8971
8	70–75	27.3983	1.812	.4649	.0427	6.0634	.0775	3.6392
10	65–70	22.3988	1.4185	.4222	.0473	6.6186	.1456	6.8370
17	60–65	17.3988	1.1506	.3749	.0839	11.9138	.2059	9.6685
10	55–60	12.3988	.8106	.2910	.1031	14.6402	.2874	13.4950
17	50–55	7.3988	.4899	.1879	.1247	17.7074	.3538	16.6130
21	45–50	2.3988	.1587	.0632	.0632	8.9744	.3940	18.5010
14	40–45	–2.6012	–.1721	.0683	.0683	18.6730	.3989	18.7080
						9.6986	.3931	19.4980
10	35–40	–7.6012	–.5028	.1925	.1242	17.63	.3516	16.5100
15	30–35	–12.6012	–.8335	.2978	.1053	14.95	.2825	13.2650
10	25–30	–17.6012	–1.1589	.3768	.0790	11.218	.2038	9.5698
4	20–25	–22.6012	–1.4950	.4326	.0558	9.924	.1302	6.1138
1	15–20	–27.6012	–1.8257	.4661	.0335	4.757	.0753	3.5359
3	10–15	–32.6012	–2.1564	.4844	.0183	2.599	.0390	1.8313
0	5–10	–37.6012	–2.4871	.4935	.0091	1.2920	.0181	.8499
0	0–5	–42.6012	–2.8179	.4976	.0041	.5820	.0075	.3522
		–47.6012	–3.1485	.4992	.0016	.2270	.0028	.1315



Test of Goodness of Fit—Case II

Interval	N_o Observed Freq.	V_o Computed Freq.	$N_o - V_o$	$\frac{N_o - V_o}{V_o}$	$\frac{(N_o - V_o)^2}{V_o}$
80–85	2	1.3348	.6652		.3318
75–80	0	2.6838	–2.6838		2.6838
70–75	8	6.0634	1.9366		.6185
65–70	10	6.6186	3.3814		1.7315
60–65	17	11.9138	5.0862		2.1713
55–60	10	14.6402	–4.6402		1.4707
50–55	17	17.7074	–.7074		.0282
45–50	21	18.6730	2.3270		.3651
40–45	14	17.6300	–3.6300		.7474
35–40	10	14.9500	–4.9500		1.6390
30–35	15	11.2180	3.7820		1.2750
25–30	10	9.9240	.0760		.0006
20–25	4	4.7570	–.7510		.1205
15–20	1	2.5990	–1.5990		1.2785
10–15	3	1.2920	1.7080		2.2580
5–10	0	.5820	–.5820		.5820
0–5	0	.2270	–.2270		.2270

$X^2 = 17.5289$
$n = 14$
$P < .25$

B. Significances of Difference between Means and between Variances

Case I:

$\bar{x}_1 = 34.0790 \qquad \sigma^2_{x_1} = 319.8911 \qquad N = 142$

Case II:

$\bar{x}_2 = 47.6012 \qquad \sigma^2_{x_2} = 228.5557 \qquad N = 142$

Difference between Means:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s}\sqrt{\frac{(n_1+1)(n_2+1)}{n_1+n_2+2}} \qquad n_1 = n_2 = 141$$

$$s^2 = \frac{1}{n_1+n_2}\{\sum (x_1 - \bar{x}_1)^2 + \sum (x_2 - \bar{x}_2)^2\}$$

$t = 6.85135$

$n = 282$

This value of t is definitely significant, and hence there is a significant difference between the means. It will be noted that we have treated the samples as independent and hence we have overestimated s, and so underestimated t.

Differences between variances:

	Sum of Squares	Degrees of Freedom	Mean Square	½ log z (e)
Case I	45424.537620	141	322.15984	2.8875
Case II	32454.91650	141	230.17671	2.7190

$z = 0.1685$
$z = 0.1387$
$o.o1$

So the difference between variances may be held significant. For Tables of t and z see Fisher, R. A. *Statistical Methods for Research Workers*, p. 151, 224.

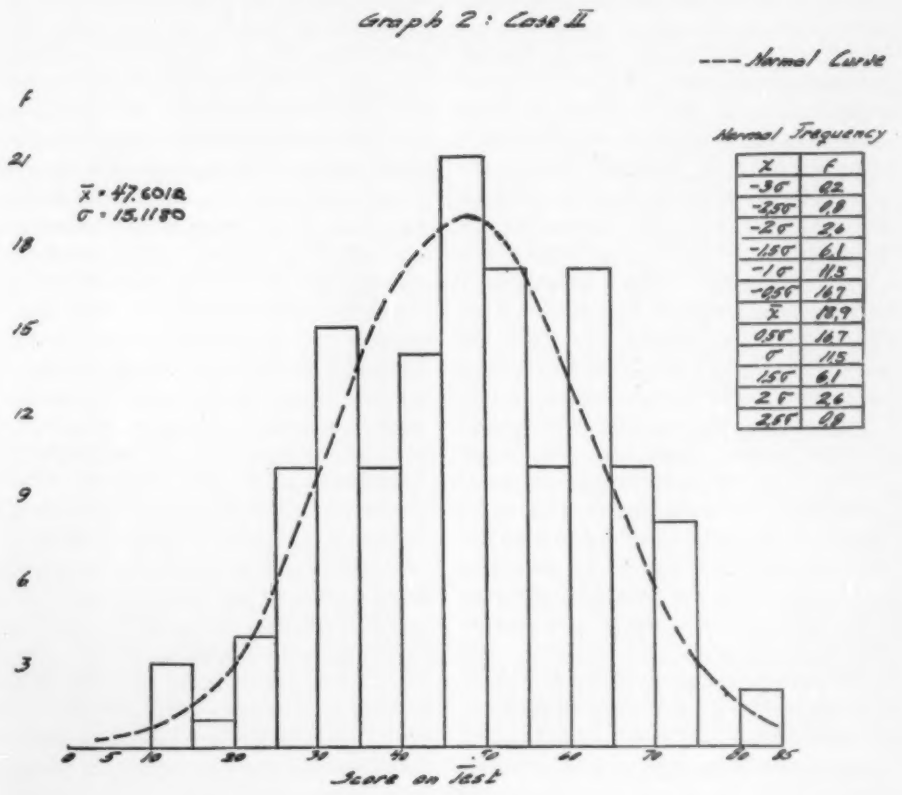
Summary and Conclusions

An examination was devised to measure some of the concomitant learnings which might be postulated for a course in Human Biology. This examination shown to be of high validity and reliability was administered to a group of 142 students in Human Biology in the General College of the University of Minnesota previous and subsequent to instruction, an interval of three months.

It has been shown that the curve of the distribution of scores changed from one best represented by Pearson's Type II Curve before instruction to one best represented by a normal curve after instruction.

It has also been shown that there was not only a significant difference between the means but also in the variances of the students' scores previous and subsequent to instruction.

It may be concluded, therefore, that there has been a significant change in the reactions of students towards common beliefs regarding health and disease, and towards the claims made relative to the effectiveness of certain home remedies and commercial preparations, over a three months' period during which they were given instruction in human biology.



TEACHING SCIENCE FOR THE PURPOSE OF INFLUENCING BEHAVIOR

VICTOR H. NOLL

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It is my purpose to discuss some of the principles that seem to me to be of primary importance in the teaching of science for purposes of influencing behavior. Some of these have already been touched upon by the chairman of our committee in his introductory remarks. However, I wish to emphasize somewhat more strongly certain principles which have been shown by recent research to be most valuable in the teaching of scientific thinking. The first of these principles is that the desired attitudes which are to influence behavior must be taught directly. To a large extent, the things we set up as objectives in our teaching are the outcomes we attain. Consequently, it would seem that if we wish to develop the scientific attitude in our pupils we must teach for this outcome. Much of our teaching of science in the past has been done on the assumption that such outcomes as scientific thinking can be relied upon to accompany the mastery of factual materials.

The recent work of Beauchamp in the National Survey of Secondary Education

showed what the prevailing viewpoint of teachers of science is on this matter.[1] Beauchamp found in his investigation of outstanding secondary schools in all parts of the country that little attempt is being made to direct attention or teaching to the accomplishments of such outcomes as the scientific attitude or the scientific method. The majority of teachers interviewed by Beauchamp expressed the opinion that such outcomes either result automatically through the teaching of facts or principles of science, or that they are taken up in the introduction to the course, or that the pupils learn these things by watching the teacher. We all know, of course, from personal observation and experience, that many teachers do not themselves have the scientific attitude nor do they have a clear notion of what it is. How, therefore, can we expect them to teach it, or how can we expect pupils to learn it from teachers who may not themselves know what it is, or practice it?

The second principle which I wish to mention is that if we wish to develop the scientific attitude, our pupils must be given opportunities to practice such an attitude. This principle has recently been reaffirmed by the work of Thorndike and his associates.[2] In brief, the principle means simply this: if we can once get a pupil to take a certain attitude our chances of getting him to take that attitude again are thus greatly enhanced. If we can once get him to be open-minded in a specific situation, our chances for having that attitude reappear are much better than if it had never been practiced. Consequently, in attempting to develop certain attitudes it is essential that we, as teachers, provide specific situations and opportunities for our pupils to exhibit the attitudes which we wish them to develop. This is nothing more than the law of exercise as stated long ago by psychologists. However, in our attempt to develop habits of scientific thinking, we seem often to neglect the principle. Once a pupil has been brought to exhibit or to take a particular attitude, be it open-mindedness, or intellectual honesty, or suspended judgment, or something else—it appears that he is much more likely to take that same attitude the next time the opportunity presents itself.

The third principle which I wish to discuss is this: if the scientific attitude or other desirable attitudes are to function in everyday life, there must be specific provision made in our teaching for generalizing these attitudes. Now I know that the term "generalization" immediately raises the spectre of formal discipline. Twenty-five or thirty years ago Woodworth, Thorndike, and many other psychologists apparently demonstrated by experimental proof that formal discipline was largely a delusion. Or at least, if any transfer did take place, the amount was so small that the effects might well be disregarded. During recent years, however, we have seen some shift in viewpoint. More recent and more comprehensive experimentation on this question has led us to the opinion that transfer of training in amounts substantial enough to justify working for it is by no means an impossibility. Extensive experiments on the high-school level have shown varying amounts if improvement in general ability resulting from the study of particular high-school subjects. It is perhaps accurate to say of our present viewpoint of the question of transfer that more or less substantial amounts of it can be made to take place providing specific provision is made in our teaching for generalization. That is, the principles, the laws, or the rules which are to be taught must be consciously and carefully generalized. Provision must be made for showing the application of principles or laws to a wide variety of situations. The pupil must be led to generalize, or to apply the same principle in different situations,

[1] Beauchamp, Wilbur L. Instruction in Science. National Survey of Secondary Education. Monograph No. 22. U. S. Office of Education Bulletin, 1932, No. 17. Government Printing Office, Washington, 1933.

[2] Thorndike, Edward L. The Psychology of Wants, Interests, and Attitudes. New York: D. Appleton-Century Co., 1934.

so that transfer may thus be facilitated. And so with scientific thinking or scientific attitudes. It is of little particular moment to develop a scientific attitude in the laboratory. We may be able to develop the habit of intellectual honesty, or the habit of criticalness, in the chemistry laboratory with reasonable success. Unless these habits are consciously and frequently generalized to life situations, however, and unless our teaching makes provision for such generalization, there is little hope that habits of thinking gained in the laboratory will function in every-day life. Unless they do function thus, there would seem to be scant justification for setting them up as important objectives of the teaching of science.

The fourth principle which I wish to mention is that if the scientific attitude or habits of scientific thinking are to become a part of the nervous systems of boys and girls in our schools, they must be made desirable objectives to them. In other words, we must somehow make these boys and girls like the scientific attitude or scientific habits of thinking if we want them to learn and use them. This principle is perhaps as important as all the others combined. Thorndike has long affirmed the importance of the law of effect as expressed in terms of satisfiers and annoyers. He stated almost twenty-five years ago that a connection which results in satisfaction tends to be strengthened while one which results in annoyance or dissatisfaction tends to be weakened. The recent work on the psychology of wants, interests, and attitudes, mentioned above, brings out more strongly than ever the importance of this principle in the development of attitudes. We cannot expect high-school pupils to want to be scientific in their thinking or behavior unless we attach satisfaction to the practice of those responses which we are trying to develop. They must seem fundamentally pleasing and desirable to them. How this may be done is, of course, difficult to say. Of one thing I am certain: we cannot make scientific thinking seem desirable to our boys and girls in schools of today by holding up to them such examples as Archimedes, Galileo, Kepler or Newton and others who have long since ceased to live. I even doubt the efficacy of holding up as examples our leading scientific men of today. I don't believe that the average pupil in our secondary schools cares very much about the kind of attitudes that such men as Irving Langmuir or Robert A. Millikan may have.

There are some living heroes, however, who do have a tremendous appeal. An illustration from life may help to strengthen this point. Some years ago, a number of boys who were inmates of an orphan asylum were playing baseball near a railroad track. One of the boys knocked the ball onto the track and in recovering it these lads found that part of the track had been washed away by a recent storm. They flagged an oncoming express train, and thus saved a number of lives and much valuable property. After their deed the boys were showered with gifts, and were given opportunities for travel and various other forms of reward. When asked what they would like most to do, what do you think their reply was? They didn't ask to see T. W. Richards make an atomic weight determination; they didn't ask to see Compton measure cosmic rays—not they! Their first request was to see Babe Ruth hit a home run!

It seems to me that there is a real lesson for teachers of science in this story. Instead of trying to make these boys and girls in our classes imitate men and women who are long since dead, and whose accomplishments and interests are so far removed from the lives and interests of high-school pupils that they are practically meaningless to them, we might try building up the desired attitudes or habits of thinking about the persons of the real heroes of these young people. If we could use as examples such persons as Lindbergh, and Greta Garbo, or others who may be worthy heroes and heroines of adolescent boys and girls, it is at least possible that desirable habits of think-

ing which might properly be identified with such objects of admiration and hero-worship might become worthwhile attainments in their eyes.

THE PROBLEM OF TESTING

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During the past fifteen or twenty years, schools of education, teachers colleges, professional books and magazines, professional societies, and teachers' discussional groups of all kinds whether formal or informal, have been greatly concerned with the refinement of measuring techniques. More attention was given to this problem, in fact, than to the whole problem of basic educational theory. Professional education has been so absorbed in learning how to measure that a realization of the need for a prior decision as to what to measure was temporarily lost.

Only recently have educators given evidence of a change of heart and taken steps to correct somewhat for the improper emphasis. In the immediate past, the major concern has been to make tests reliable, objective, and easy to administer. Now more attention is coming to be given to the business of making them valid. Not alone must tests measure easily and reliably what they do measure; in addition, they must measure more nearly what it is intended they should measure.

In an article written in 1929, I attempted to show how objective tests may be used to measure something more than mere recall of subject matter. I tried to show how they may be designed to measure the student's ability to use or apply ideas in novel situations.* One of the major objections to objective tests has been that they measure only the student's ability to recall specific information. While this objection may have been valid for the objective tests then in vogue, it did not need to be so.

With careful preparation, objective tests can be made to determine the student's ability to apply generalized ideals as well as to recall specific information. Tests in mathematics, for example, have done this for a long time. The arithmetic teacher who wishes to test a pupil's ability to use the process of long division does not usually give problems on an examination which the pupil has already worked in class. Sheep, apples, and pet rabbits may have been used during the period of instruction, while kittens, express wagons, and airplanes may be used in the examination. The process of long division will be applicable in all cases, but the objects used in setting up the problems will be different. Thus the pupil is tested for his ability to use long division in any and all cases which demand it, rather than only in those covered specifically by the previous instruction.

Such a principle of testing is as applicable and important in science and history as in mathematics. For example, instruction in a particular class may deal with the dependence of climate upon various factors such as the general temperature zones, the prevailing winds, the topography or "lay" of the land, the location of large bodies of water, and so forth. On an examination, the teacher might ask the student to describe the climate of one or more of the particular localities studied previously in class. Such an examination might possibly test the student's ability to apply his information, but it would probably test, for the most part, his ability to remember what was said in class.

In order to test the pupil's ability to apply what he has learned about climate, one would need to state a proposition based

* Bayles, Ernest E. "Testing for Comprehension," Journal of Educational Research 22: 268–273; November, 1929.

upon an entirely new locality, make available the necessary factual information, and call for a judgment. In such a case, the student's recollection of specific answers reached in class would be of little avail. He would simply have to "figure it out."

One might use a statement such as the following and call for the pupil's judgment as to its truth or falsity: "The climate of the region one hundred miles south of Buenos Aires, Argentina, is moist and warm in February, and very cold and dry in August." Without previous instruction with regard to that particular locality, most pupils at the present time would throw up their hands and plead, "Unfair, unfair!" Such an item probably would be unfair if the pupil had not been instructed in the way he should proceed to answer items of that kind. With the right previous instruction, however, such an item would not be unfair, and would not be beyond the grasp of the ordinary ninth-grade pupil. This statement is made with confidence for it has been corroborated time and again in actual, normal classrooms.

Safeguards have to be applied in order to make sure that the student will "think the matter through," rather than merely guess, but such safeguards are easily possible. It is not necessary here to discuss them in detail. The point at issue is that it is possible to test for the comprehension of general ideas by the use of objective examinations, even though such an end is not widely achieved by the examinations which are now in use.

But even though comprehension tests of an objective nature may be possible, there is much yet to be said with regard to an adequate and valid testing program. It seems not to be widely recognized that there is a considerable difference between "straight thinking" and "thoughtfulness" as educational objectives. These two objectives are so alike, and yet so different, that a short digression is here necessary to distinguish between them.

Straight thinking, as the term is normally used, means thinking in accordance with established lines of thought or belief. Straight thinking is not to be confused with memorization because one can think straight about matters which one has never actually met before, while one can remember only that which is part of one's former experience. One person might ask whether it will rain tomorrow. Another might answer that the evening paper predicts fair weather, that a cloudless sky and a stationary barometer tend to corroborate the prediction, and the likelihood is that such a prediction will prove correct. Such an answer is not based on memory for it deals with futures rather than the past. But in so far as such an answer is in accordance with proven principles of weather prediction, it constitutes an example of "straight thinking."

Thoughtfulness would not necessarily be involved in such an answer, however. No casting about for possible answers is implied; the answer is immediately given. This is a case of action rather than thought; action in the form of speech, it is true, but action nevertheless.

When in the enviable position of knowing exactly what to do next, and acting on that basis, one gives clear evidence of straight thinking. But evidence of being thoughtful is furnished only when one does not know immediately what to do next. Thoughtfulness implies hesitancy; pausing first to consider various lines of action, looking into each of these to see what will come of it and what influence it may have on other lines, and finally coming to a decision based upon the outcome of such a period of reflection. Thoughtfulness implies a problem and the consequent problem-solving activity. Straight thinking does not imply a problem; it implies only a novel situation, and adequate, non-hesitant action which resolves the situation with precision and dispatch.

If the teacher aims at straight thinking as the major educational outcome, the development of thoughtfulness on the part of

the student comes only by chance, if at all. If, on the other hand, the teacher persistently strives to bring the student to reach each and every conclusion through a reflective or thoughtful process, the student will not only become more thoughtful, but he will also be successful in achieving new areas in which he can "think straight." It would therefore seem highly desirable that the teacher should aim primarily at developing thoughtfulness, rather than straight thinking.

The scheme of testing for comprehension outlined above is one which delves directly and rather thoroughly into the student's ability to "think straight." A judgment about the statement regarding the climate of South America would be considered acceptable if it were in accordance with previously accepted general conclusions regarding winds, temperature zones, topography, and so forth. It might possibly be, however, that the exact location selected actually embodies special conditions which cause the climate of that particular locality to be different from what one should expect from the general rules. Thus, in order to maintain the validity of the test as a determiner of straight thinking, the right answer would have to be taken as the one which accords with the generalized situation, rather than the one which is true of the specialized case. An individual may think straight—that is, in accordance with the accepted rules—and still be wrong about a given exceptional case. In order to measure the pupil's ability to think straight, the test must determine whether or not the pupil arrives at answers which are demanded by the system of thought which is considered acceptable.

Suppose, however, a given pupil, unknown to the teacher, happens to be familiar with the geography of that particular portion of South America, knows that it is exceptional, and gives the geographically correct answer rather than the one expected by the teacher. If the answer alone is recorded on the student's paper, no opportunity being given for comment, the teacher will afterwards doubtless mark the student's answer wrong because there is no way of knowing that such a student knew more of that locality than another student who might have given such an answer in complete ignorance of either the rule or the exception. On an objective examination, the answer alone is the sole and only basis for the teacher's judgment of the adequacy of the student's thought processes. Objective examinations are right-answer examinations. Objective examinations are therefore strictly appropriate only if a right-answer pedagogy is in force! a pedagogy in which the pupil must agree with the teacher; one which assumes that certain answers are right and it is the pupil's major business to know those answers.

Can a testing program which puts a premium on the docile acceptance of beliefs and conclusions acceptable to the teacher be considered a respectable testing program? Can a theory of teaching which is in keeping with such a testing program be considered adequate? What is needed today is a teaching and testing program which implies and achieves thoughtfulness on the part of the student rather than one which seeks and measures only straight thinking. Whether difficult to administer or not, no testing program can well be considered adequate or satisfactory unless it gives full recognition to the fact that the student may at times justifiably disagree with the teacher and receive greater credit for disagreeing than for agreeing. Such a testing program must differentiate between intelligent disagreement and disagreement due to ignorance. To make such a distinction is difficult, and is virtually impossible through the agency of an objective test.

This is a knotty problem. What is the answer? In the first place, the full and complete answer is probably not obtainable by means of any written examination. Answers which the pupil accepts at a given time may be completely untenable in the

light of the evidence which the teacher has at his command, but may be perfectly logical in the light of the evidence available to the pupil. The teacher must look at the pupil's answers on the basis of the data available to the pupil. In the examination the teacher must therefore give the pupil an opportunity to present the data and the logic used in arriving at his conclusions. The teacher should know also what are the pupil's attitudes regarding the conclusions which he reaches. Is he, on the one hand, cocksure and dogmatic, or, on the other, utterly timid and vacillating? Neither extreme is characteristic of a scientifically-minded man. The thoughtful student is open-minded, but not too much so. He is not so open-minded as to be willing to accept any and every idea that comes his way. He is not simply open-minded; he is tough-minded—willing to be convinced, but not without convincing evidence. Moreover, he needs not only to be willing to be convinced, but should be continually seeking to be convinced. In other words, a thoughtful individual is one who believes, and abides by the consequences of the belief, that the quest for truth is far more sacred than any particular formulation of truth. As soon as he loses such an attitude, he ceases to be thoughtful.

It may be necessary, and doubtless will be, that the teacher determine from time to time just what conclusions the pupils, individually and collectively, have reached. On the whole, the more thoughtful pupils, especially in the natural sciences, will have reached conclusions acceptable to specialists in the field. For the most part, too, the more thoughtful pupils will have reached the greater number of generally acceptable conclusions. Therefore, for the purpose of determining a grade—since grades are still with us—comprehension tests, as well as mere information tests, can doubtless be used with profit. It would seem that such tests should be of an objective nature and very carefully formulated.

For the purpose of making a direct test of thoughtfulness, however, objective tests appear to be entirely unsuited. What should be the nature of such a test? It may well be twofold. First, it may include a written essay in which the student is given a single challenging problem—one which really causes him to pause for reflection, to consider alternative answers, to marshal and organize the information which he possesses, and possibly to find new information. He should be given sufficient time to write a comprehensive answer; more than a single class period if necessary. Such a paper should be judged upon three bases: first, whether or not all reasonably available and pertinent data have been taken into account; second, whether or not the conclusions are in agreement with the data that are being considered; and third; whether or not the conclusions are in agreement with other conclusions known to have been accepted by the student. Such a paper should not be given a low mark merely because the conclusions fail to agree with those of the teacher or with other generally accepted conclusions.

In addition to the written portion, the test for thoughtfulness should also include the general examination which the teacher is making continually by observing the student in his various walks of life. What is his general attitude in the classroom and outside? Does he tackle problems earnestly, thoughtfully, seriously, when he considers them worth tackling? What types of problems does he consider worth tackling? What generalized attitudes has be developed toward life? How quick is he to sense problems when he meets them? Does he jump to conclusions, or is he slow to become convinced? Is he bullheaded and argumentative, is he namby-pamby—perfectly willing to accept any conclusion just so it relieves him of responsibility—or is he tough-minded, yet glad for the opportunity to discuss moot questions? Which is of greater concern to him: who is right, or what is right?

I believe that a careful judgment by the teacher, having a twofold basis such as this, is, in the long run, a far better means of testing for thoughtfulness than any objective examination which has yet been devised.

A COMPARATIVE STUDY OF THE EFFECTIVENESS OF STUDENT-MADE AND PREPARED DRAWINGS IN COLLEGE LABORATORY WORK IN BIOLOGY*

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The present study is concerned with the evaluation of two methods of laboratory procedure, (1) the "time-honored" procedure of having students make drawings from their observations of the specimen, and (2) a comparatively new procedure of having students make their observations, and, instead of drawing, merely label prepared drawings.

The procedure of making laboratory drawings has been criticized as being a "pedagogical formalism." Moreover, it consumes a great deal of time, thus preventing and minimizing the opportunities for more important outcomes, such as the development of the scientific attitudes and the realization of the significance of science in everyday life. The procedure of using prepared drawings has been proposed on the ground that it is equally, if not more, effective with regard to the acquisition of facts, while it gives greater opportunity for the development of more desirable outcomes inasmuch as it consumes far less time.

The studies of Ayer,[1] Bryson,[2] and Baird[3] all substantiate the conclusion that the representative type of drawing is a sheer waste of time. Yet, according to Ballew[4] and Baird the majority of required biological drawings are of this type. Hunter[5] deplores this situation in his analysis of the misuse of the laboratory.

Where the student encounters great difficulty in drawing, it is doubtful whether the added time spent in producing only a fair drawing has been profitably spent. Where laboratory drawings are graded, there is the tendency to mark on excellence of line work rather than on accuracy of factual depiction. In any event, the correlation between the excellence of laboratory drawings and achievement in laboratory work has not been established. Where the quantity or quality of laboratory drawings is stressed, emphasis tends to be shifted from the materials under observation to the making of artistic or numerous drawings.

A widespread use of a teaching device which consumes a great deal of time and which is subject to such frequent misuse raises an important problem as to its desirability. Must the student make drawings to learn? Will he retain his knowledge as

* Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Education, in the School of Education, The College of the City of New York. January, 1935.

[1] Ayer, F. C. *The Psychology of Drawing With Special Reference to Laboratory Teaching.* Doctor's Thesis. Baltimore, Maryland. Warwick and York, Inc., 1916, p. 107–168.

[2] Bryson, O. F. *The Extent to Which Drawings Contribute to an Understanding of Scientific Facts.* Reported in *Third Yearbook, Department of Superintendence, National Education Association,* 1925.

[3] Baird, D. O. *A Study of Biology Notebook Work in New York State.* Contributions to Education, No. 400. New York, Teachers College, Columbia University, 1929.

[4] Ballew, A. M. "An Analysis of Biological Drawings," *School Science and Mathematics* 30: 490–497; May, 1930.

[5] Hunter, G. W. Science Teaching at Junior and Senior High School Levels. New York, American Book Co., 1934. p. 172–175.

readily if he does not represent on paper what he sees with his eyes? Is a poor and inaccurate drawing which represents the best efforts of an inferior student worth the time it has taken to construct? Can ready-made drawings be used as a tool for acquiring knowledge just as the other laboratory equipment is used?

Those who advocate the prepared drawing claim that it can be substituted in full, or in part, for the student drawing with no loss of efficiency on the part of the student to observe or remember. Their main argument is that of the time saved. Can this time be spent more profitably on the observation and dissection of the specimen, and the use of other visual aids such as motion pictures, lantern slides, models, charts, modeling in clay, *et cetera*.

To secure objective data on these questions, an "equivalent-groups" experiment was conducted to determine the relative effectiveness of student-made and prepared drawings with respect to the acquisition and retention of factual knowledge. The subjects of this study were approximately 250 students taking the second semester of a course in elementary biology at the College of the City of New York. The first semester of this course is devoted to a study of the simpler groups of plants and animals, while the second is devoted to a study of the higher types, and also to a consideration of the general problems of genetics, embryology, and evolution. The subjects were divided into an experimental and a control group, of eight sections each. These met once per week for a four-hour laboratory period.

The two groups were equated on the basis of intelligence and the experimental trait to be measured as indicated below. The trait measured was ability to do laboratory work, using (1) student-drawings, and (2) prepared drawings. At the end of the period during which these experimental factors were operating, a final objective test was applied to each group to measure the effects of each method. Several weeks later a second test was applied to measure retention.

In conducting an experiment of this type it is essential that both groups be equated for the trait which is to be measured, namely, ability to do laboratory work in biology, and ability to profit by instruction and procedure. Since it is not possible to measure these capacities directly, an indirect method was used. It is apparent that any such capacities will be dependent upon two factors, innate ability (intelligence) and experience (training in science, previous record in biology, attitude toward science, and toward biology in particular). Upon these considerations the following traits were selected as a basis for equating the groups: (1) Intelligence. Statistics compiled by the personnel bureau of the College and based on the Thurstone Psychological Examination issued by the American Council on Education were used. The percentile rating for each individual is based upon the norms for the particular form taken. The average for the control group (student-drawings) was 75.0, S.D. 21.4. The average for the experimental group (prepared drawings) was 74.5, S.D. 20.5. In this way two groups of students, 104 in the control, and 109 in the experimental, were obtained having similar averages and variabilities. (2) College class. The majority of the students in each group were juniors. (3) Registration for science or non-science degree, (4) Intention to major in biology, (5) Number of terms of biology taken in high school, (6) Number of terms of physics taken at the college, (7) Number of terms of chemistry taken at the college, (8) Number of terms of Science Survey, and (9) Grade in biology I. Both groups were approximately equivalent for *all* of the above traits.

The present study is limited to a three-week period on the laboratory study and dissection of the frog. The unit on the frog was chosen, first, because it afforded a

short, but significant period of work, and second, because it occurs so frequently in the curricula of high schools and colleges, and thus comprises a set of typical laboratory exercises.

The laboratory procedure was as follows:

1. Introductory talk by the instructor, in which are explained the purpose of the laboratory exercise, the technique of dissection, sections of the laboratory manual to be followed, and drawings to be made. (15 to 45 minutes.)

2. Laboratory exercises proper, in which the students dissect their own specimens, make observations and drawings of their observations, and use other supplementary aids such as charts, reference books, prepared dissections, *etcetera* (major portion of the period).

3. Recitation on the work taken up in the laboratory.

In order that the procedure used in this experiment be most valid, it is essential that all factors influencing the final measure, except the one factor under investigation—that of method—be kept as nearly as possible the same for both groups. The experiment was so arranged that as far as possible the same instructor taught a control and an experimental section. Of the 16 sections, 12 were taught in this manner. Moreover, the instructor was careful to discuss the same subject matter in his control and experimental sections. The same set of laboratory outlines were followed by all students. The laboratory outlines require the construction of seven laboratory drawings. In the case of the experimental sections these drawings were not made by the students, but prepared drawings to be labeled were supplied instead. The importance of the influence of the "fatigue curve" on the student's performance during the course of the day has been emphasized in educational literature. This factor was kept constant since all the sections, but two, met from 2 to 6 in the afternoon, one control and one experimental section meeting Saturday mornings from 9 to 1. Since it was not possible to have all sections meet in the same laboratory, an effort was made to see that all equipment was the same for all sections.

The student-drawings made by the control group included both the representative and the analytic types. They showed by suitable labels the various structures mentioned in the manual. The prepared drawings* were taken from various sources, and fulfill the requirements of the drawings called for in the laboratory manual. All the drawings were copied or enlarged, and prepared for mimeographing by the author. While making his observations, the student was required to label the structures indicated on the prepared drawings.

The final test was made up of 55 "new type" objective questions with a maximum score of 100. The items were selected by members of the biology department and the author, and were designed to measure the following types of factual information: (1) names of structural parts, (2) interpretation of structure in terms of its function, (3) physiology of parts based upon anatomical relationship, (4) knowledge of habits of the living organisms. Since the test was to be given on successive days, it was necessary to draw up two forms in order to reduce the communication factor. Since the items on the retention test were taken from the final test, both tests measured the same type of information.

Some measure of the validity of the tests used was secured by the correlation, based upon 130 cases, obtained between initial laboratory grades given by the instructor previous to the beginning of the experiment and the final laboratory grades, which correlation was found to be $.30 \pm .05$ (S.D. 3.67), as computed by the Pearson product-moment method. The correlation is low, but positive, and is not to be interpreted as a true measure of the validity of the test. It does, however, indicate some degree of objective validity. On the basis of the

* A complete set of drawings, tests and tables are included in the body of the thesis (unpublished).

criteria set up for the selection of items, the test was assumed to be sufficiently valid to warrant the conclusions drawn.

Since the tests used could not well be repeated the reliability of half of the test was measured, and then by Spearman's formula the reliability of the whole test was found. The reliability of the whole test was found to be .52 ± .05.

While a minimum reliability coefficient of .80 is usually considered to be a reliable measure of a capacity, Thurstone points out that the coefficient of reliability depends upon the size and variability of the group. Using a comparatively homogeneous group, mostly college juniors, the coefficient is likely to be lower than if it were determined upon a group showing a greater degree of variability, for example, high-school, undergraduate and graduate students. The coefficient of correlation obtained (.52) is therefore assumed to be sufficiently reliable to warrant the conclusions drawn.

The reliability of the parallel test (Test 1, Form B) and of one of the tests for permanent retention (Test 2, Form B) computed by the same method were found to be .51 ± .05 and .69 ± .03 respectively.

In each case the mean, standard deviation (S.D.), and difference in obtained means were computed. The "critical ratio," the difference in obtained means divided by the standard error of the difference, was computed in each case in order to determine the significance of the obtained difference.

Since matching has a restrictive influence upon chance fluctuations in the means, the following formula suggested by Lindquist and Wilks was used in determining the standard error of the difference in obtained means:

$$\sigma \text{ diff.} = \sqrt{\left(\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}\right)(1 - r^2)}$$

where N_1 and N_2 represent the number of cases in each group, and where r represents the Pearson product-moment coefficient of correlation between the measures used as a basis for matching and the measures between which the final comparison in means is made. The restrictive influence of matching in this experiment, however, was negligible since r was found to be .004 ± .05.

The results of the final test are summarized in Table I. The number of students in the control group (student-drawings) was 103, in the experimental group (prepared drawings) 109. The means for the control and experimental groups were 71.4 (S.D. 11.6) and 67.7 (S.D. 13.2) respectively. The difference in means in favor of the control group was 3.7. The standard error of the difference was 1.64. The "critical ratio" was 2.0. A

TABLE I

ACHIEVEMENT ON THE FINAL TEST

	N	*Mean*	*S.D.*	*Diff.*	*σ Diff.*	*Critical Ratio*
Student-drawings	103	71.4	11.6	3.7	1.84	2.0
Prepared drawings	109	67.7	13.2			

Standard error of the difference $= \sigma_{diff.} = \sqrt{\left(\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}\right)(1 - r^2)}$

where N = the number of cases.

σ_1 = standard deviation of student drawing group.

σ_2 = standard deviation of prepared drawing group.

r = coefficient of correlation between intelligence ratings and scores on the final test

Diff = difference in obtained means

Critical ratio $= \frac{\text{diff}}{\sigma \text{ diff}}$

S.D. = standard deviation

difference having a critical ratio of 3 is usually considered significant. The critical ratio obtained (2.0) indicated that the obtained difference was not statistically significant.

In order to determine whether the success of either method depended upon the individual differences of the students, *i.e.*, whether student-drawings or prepared drawings were (1) equally superior with good as with poor students, (2) superior with good students, but inferior with poor students, (3) *vice versa*, two groups above percentile rating 50 were equated for intelligence and their achievement on the final test compared. Tables II and III show that neither method showed a distinct superiority with "bright" as with "less bright" students.

A further comparison was made between the A students, *i.e.*, students who received the grade of "A" in Biology I, of the control group and the "A" students of the experimental group. The same was done for "B," "C," and "D" students. Tables IV to VII show that neither method was superior for any one of these types of students. The small differences in each case were not statistically significant.

To measure permanent retention, two groups of students, 71 in the control and 77 in the experimental, were given a short test three weeks after the completion of the work on the frog. The results are shown in Table VIII. The mean for the control group was 62.04, S.D. 26.3. The mean for the experimental group was 60.06, S.D. 25.7. The difference in means was 1.98 in favor of the control group (student-drawings). This obtained difference was not statistically significant.

SUMMARY AND CONCLUSIONS

An equivalent-groups experiment was conducted to determine the relative effectiveness of student-made and prepared drawings in college laboratory work on the frog.

It was found that

(1) In the test measuring immediate

TABLE II

Comparison of Achievements of Students Above P.R. 50

	N	*M.P.R.*	*S.D.*	*Av. Achiev. on F.T.*	σ	*Diff.*	σ *Diff.*	*Critical Ratio*
Student-drawings	86	82.7	23.5	74.9	10.5	.7	16.8	.04
Prepared drawings ..	90	82.7	20.5	74.2	13.3			

where N = number of students in each group.
M.P.R. = mean percentile rank.
S.D. = standard deviation of percentile rank.

$$\text{Av. Achiev. on F.T.} = \frac{\text{average achievement on final test}}{\text{standard deviation on final test}}.$$

Diff. = difference in obtained means.

$$\sigma \text{ diff.} = \sqrt{\left(\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}\right)(1 - r^2)}$$

$$\text{Critical ratio} = \frac{\text{diff.}}{\sigma \text{ diff.}}$$

TABLE III

Comparison of Achievement of Students Below P.R. 50

	N	*M.P.R.*	*S.D.*	*Av. Achiev. on F.T.*	σ	*Diff.*	σ *Diff.*	*Critical Ratio*
Student-drawings	17	36.4	9.5	71.0	14.6	5.0	16.6	.30
Prepared drawings ..	14	38.2	7.5	76.0	8.0			

TABLE IV
COMPARISON OF ACHIEVEMENT OF "A" STUDENTS

	N	*Mean on F.T.*	σ	*Diff.*	σ *Diff.*	*Critical Ratio*
Student-drawings	10	87.7	4.4	2.7	8.8	.31
Prepared drawings	16	85.0	7.7			

TABLE V
COMPARISON OF ACHIEVEMENT OF "B" STUDENTS

	N	*Mean on F.T.*	σ	*Diff.*	σ *Diff.*	*Critical Ratio*
Student-drawings	32	80.0	9.5	1.9	15.1	.13
Prepared drawings	27	78.1	11.9			

TABLE VI
COMPARISON OF ACHIEVEMENT OF "C" STUDENTS

	N	*Mean on F.T.*	σ	*Diff.*	σ *Diff.*	*Critical Ratio*
Student-drawings	43	72.4	11.9	.1	16.5	.007
Prepared drawings	44	72.3	11.5			

TABLE VII
COMPARISON OF ACHIEVEMENT OF "D" STUDENTS

	N	*Mean on F.T.*	σ	*Diff.*	σ *Diff.*	*Critical Ratio*
Student-drawings	17	71.9	10.0	7.4	15.9	.47
Prepared drawings	18	64.5	12.4			

TABLE VIII
COMPARISON OF ACHIEVEMENT OF CONTROL AND EXPERIMENTAL GROUPS ON THE PERMANENT RETENTION TEST

	N	*Mean*	σ	*Diff.*	σ *Diff.*	*Critical Ratio*
Student-drawings	71	62.04	26.3	1.98	4.3	.46
Prepared drawings	77	60.06	25.7			

retention there was a difference of 3.7 in favor of the students who made their own drawings. The critical ratio was so small as to indicate that there was no certainty that the difference was significant.

(2) In the test measuring permanent retention there was a difference of 1.98 in favor of the students who made their own drawings. The critical ratio was so small as to indicate that there was no certainty that the difference was significant.

(3) In comparing the achievement of superior and inferior students it was found that neither method showed a distinct superiority at any level of ability.

(4) It was found that in general it took

less time to make observations and label the prepared drawings than to observe and make original drawings.

The general conclusions may be stated as follows:

(1) The procedure of labeling prepared drawings and the procedure of making original drawings are equally effective with regard to the student's ability to acquire and remember factual information from his laboratory observations.

(2) The two methods are equally effective at all levels of student ability.

(3) It requires less time to make observations and label prepared drawings than it does to observe and make original drawings.

(4) The prepared drawing procedure is more economical and hence more effective since it requires less time to be spent in drawing, and allows more time for observation and other laboratory activities. It is presumed that this time saved may be used to develop the more valuable outcomes of laboratory work.

(5) It is suggested that the prepared drawing replace the student drawing especially where the drawing is too difficult or is of the representative type.

The present study substantiates the work of Taylor. Although she found a "consistent increase in achievement for those who did not make drawings" in an elementary course in plant biology, the present study has shown that prepared drawings are just as effective as student-drawings in connection with animal biology. It would seem from these studies that the prepared drawing has considerable pedagogical value, and might be incorporated with profit into the teaching method in elementary courses in biology.

[7] Lindquist, E. F. "The Significance of a Difference Between "Matched" Groups." *Journal of Educational Psychology*, Vol. XXII, No. 3, March 1931.

[8] Taylor, L. "The Ready-made Drawing with Relation to Student Achievement," *School and Society*, September 13, 1930, Vol. XXXII.

[9] Thurston, L. I. *The Reliability and Validity of Tests.* Ann Arbor, Michigan, Edwards Bros., Inc., 1932.

[10] Wilks, S. S. "The Standard Error of the Means of *Matched Samples*," *Journal of Educational Psychology*, March 1931, Vol. XXII, No. 3.

Editorials and educational news

APPRECIATION OF . . . AND SCIENCE

Art, literature, and music are ways of making a living, but there would be little literature, less art, and no music if hard-headed humanity did not possess a type of softness called *appreciation.* Science is a field of practical employment, and there would be science taught and used even if there were no pleasure in it, yet throughout the centuries science has been offered primarily for appreciation to all who could or would accept it on that basis.

Examples of this appeal to interest are to be found all along the line of scientific literature. What but a book of popular science was *Porta's Book of Natural Magick,* published first in 1556 as a small volume of four chapters when John Baptista Porta of Naples was a lad of 15, and expanded in 1616 to an encyclopedia of twenty chapters when he was a veteran of 65! The latter volume was translated into many languages, including English.

For the next generation there was Philip's *Technical Curiosities*—but let the easy Latin of his fly-leaf describe the offering:

Technica Curiofa, of Joannem Philippum, 1644.

Libris XII comprehenfa, quibus varia Experimenta, variaque Technafmata, Pnevmatica, Hydravlica, Hydrotechnica, Mechanica, Graphica, Cyclometrica, Chronometrica, Automatica, Cabaliftica, aliaque Artis arcana ac miracula, rara, curiofa, ingeniofa, magnamque partem nova & antehac inaudita, eruditi orbis utilitati, delectationi, disceptationique proponuntur.

I will match[1] the versatility, originality, and pleasing style of these science books for the *delectation of the erudite world* against all of their successors.

What is appreciated by enlightened people? Is it *adventure*? The story of science is full of daring and doing. Is it *mystery*? What tales more than those of science reek with the earnestly sought Unknown? Is the *work-and-win* story enjoyed by hero-worshippers? Who have surpassed the Frank Merriwells of science in their achievements and rewards? Does *magic* thrill? Who have rubbed more lamps than the Aladdins of science? Is a *moral lesson* desired as a prescription for self or student? What literature and logic more nearly points the way to truth and wisdom than do the philosophers of science?

Is appreciation inherited, or acquired? Is one born appreciative, or does one learn so to be? The collective judgment of those who know the influences of art, literature, and music is that appreciation is predominantly a matter of training, and primarily of *early* training. It is a matter of background, and beginnings are important.

There are definite efforts in this country to foster science appreciation. Curricula offer the hours, publishers the guides, understanding teachers the service, at all edu-

[1] I saw these books, and others of succeeding centuries, in the Library of Congress at Washington, D. C.

cational levels. Science in the kindergartens and earliest grades has its specially adapted literature.[2] In the intermediate grades there is a recent flair for profusely illustrated volumes[3] to the delight of many at this age of understanding eagerness. As texts in general science and biology become more formal in the junior high school, there are at least a hundred supplementary volumes on this level published every year that shout, "Science is still fun!"[4] When the science specialties of senior high school are attacked, a hundred more new non-text books cry out, "Science is still interesting!"[5]

From kindergarten through high school, therefore, the opportunities for developing appreciation of science are many—the beneficiaries, relatively few.

A last chance to provide this highly useful background of appreciation comes with the freshman year in college. In the realization that, in spite of twelve years in which to do it, the curricula and instruction of the lower levels have not graduated a majority of organized and appreciative minds, a frantic effort is made to supply the background and appreciation by means of sundry survey and orientation courses.[6] These are, and will continue to be, necessary in science until the effective twelve-year program in science becomes established throughout the nation.

Perhaps—to dodge no duty—we should ask a question of our readers. "Do *you* know how to develop the appreciation of art, literature, music, *and science* within yourself and your students?" If you do not, there are plenty of ways to find out.

Hanor A. Webb,
George Peabody College for Teachers

THE TEACHER WE DON'T FORGET

Not long ago, about one hundred young teachers of science gathered to discuss problems in science club sponsorship. To say that they all were there because of compelling interest in a professional problem would be something of an exaggeration. Many, no doubt, would have experienced little difficulty in finding more pleasant and more restful places to spend an evening after a hard day's work. But, what is one to do, when the supervisor "believes" in science clubs and expects teachers—especially the younger ones—to "show professional spirit" by devoting time to extra-curricular activities? And so, they came.

There was a program and an outline for discussion; but the conference moved independently of any outline through three different phases.

In the beginning, there was a tendency to complain against conditions which make science club work difficult. Teaching five classes a day—forty-five pupils in a class—is a tiring load. Besides, a science teacher must set up and try out demonstrations. Also, one's official class and study-hall assignment take time and energy. Suppose a school is on double-session, where can one find a room available for a club meeting? Who will supply the materials and equipment? Is a club sponsor covered against legal responsibilities if an accident occurs

[2] Among the newest are *Science Stories,* two volumes or more, by Wilbur L. Beauchamp and others, The Reilly & Lee Co., Chicago.

[3] For example, *Automobiles from Start to Finish,* by Franklin M. Reck, Thomas Y. Crowell Co., New York; *Talking Wires,* by Clara Lambert, The Macmillan Co., New York.

[4] Typical of this spirit are *The Earth for Sam; The Stars for Sam; The Sea for Sam;* each by W. Maxwell Reed, Harcourt, Brace & Co., New York.

[5] At this, and college freshman, level there are certain books that particularly "hit the mark," such as *Stars and Planets* by Donald H. Menzel, *The Smallest Living Things* by Gary N. Calkins, *The Plant World* by C. Stuart Gager, *The Races of Man* by Robert B. Bean, *The Coming of Man* by George Grant MacCurdy, and others, all concise (150 pages, more or less) and inexpensive volumes published by The University Society, New York.

[6] Most recent and lively are the "new-plan texts" of the University of Chicago: *From Galileo to Cosmic Rays—a New Look at Physics,* by Harvey B. Lemon; *Highlights of Astronomy,* by Walter Bartky; *Down to Earth,* by Carey Croneis and William C. Krumbein; *Man and the Vertebrates,* by Alfred S. Romer; *The Story of the Plant Kingdom,* by Merle S. Coulter; these are "unorthodox but fascinating."

while the club is on a trip? How about clerical help for the club sponsor? Why don't supervisors tell us how and help us to manage science clubs? If science clubs are worth so much educationally, why are they not included in and credited for curricular requirements?

If the evening had ended on this note, one might have drawn sad conclusions concerning the professional spirit of the group or the possibilities of science club work. As a matter of fact, the impatience and the complaining was merely a process of blowing off steam. The conference soon took a different turn and entered its second phase. What is a good science club, anyway? What do you do when you run out of interesting things to do? How do you avoid "cliques"? What kind of meetings do you arrange? What do you do in photography, in radio, in microscopy, astronomy, *etcetera*? How many members should a club have? How do you connect club work with class work? And so on. As answers followed questions, note-taking became prevalent. It soon became very clear that there *was* a technique of successful science club sponsorship and that the continued pooling of sponsor experiences might lead to a formulation of important elements in that technique.

Gradually, the discussion developed a third and final phase which is best described by the question, "What does the pupil get out of a science club?" Many answers were suggested. Some stressed the fact that only in science clubs can the teacher really care for individual differences among pupils. Some pointed to club work as the only true example of pupil learning by experience. Others showed that the science-club activity was the only means of introducing into public schools the spirit and the method of the private "progressive" school. Still others pointed to the club as an antidote against the tendency to neglect individual laboratory work. Many urged the science club as a means of reaching the large numbers of non-academically-minded pupils now attending high schools because of the economic depression. The most significant answer of all, and one which implied a summation of most of the discussion, came from a science club sponsor who said:

"When I think back to my high school days, I do not remember subjects; I remember teachers. Most of them are vague in my mind; but the few who stand out are the ones who used to meet me after class. I remember them because they gave me things to do and to think about; they changed my life. That is why I shall continue to sponsor a club. I know that in a club atmosphere the pupil can grow educationally and I professionally."

MORRIS MEISTER,
Haaren High School, New York City

SUCCESS

Intrigued and curious after two long distance telephone conversations with a former student of mine, regarding the food of certain live animals in the classroom, I turned my car in the direction of the Sourland Mountains one fine October afternoon to hunt for the rural school where she is teaching.

The two-room frame building hugged the side of a hill. Sunlight streamed across the floor through the long southwest windows. A motley group of over forty children of grades five to eight was being dismissed in the two rooms at the afternoon's close. After they had left, the teacher told me of her chagrin when, on entering the school in September, the children had informed her with pride that theirs was the worst school in the county, that no teacher ever stayed long and that they had chased the last teacher out onto the hillside through the long southwest windows.

Six weeks had passed since that day. She and her colleague were still there and school was going on in an orderly fashion. She attributes her success to the science work. Each class has a science period every day. First, this period was spent at the brook where they found frogs, a painted turtle, a snapping turtle, minnows, and a

crayfish. To observe their habits more closely the animals were brought in. The school board grudgingly said that if the teaching of science demanded that animals be kept in the classroom, the teacher might keep them there. A northeast alcove in one room became the science museum. No aquarium was at hand, but the discarded top of an old Victrola from the school attic was inverted and converted into an aquarium. An old metal lantern case made a terrarium for the pickerel and green frogs collected. The children have been learning to feed the animals and have experimented with foods and methods of feeding. Mounted butterflies and other insects gave evidence of other field trips in the neighborhood of the school.

There is no doubt in my mind but that the science work of this inexperienced teacher has a vital quality which is essential to successful teaching in the elementary school. This quality has built for success in the science teaching itself and also in the creation of attitudes of mind furthering the teaching of other subjects.

What shall we look for in science teaching today? If school is a place where life develops for the child, then the science must be functional. It is not through passive listening, reciting and listening again that children learn, but through actual experience. At present these rural children are learning to understand and appreciate their environment by learning about the life processes and interrelationships of living things. The satisfaction in this beginning is providing an interest which the teacher can utilize in providing still other science experiences having to do with health habits, with the destruction of superstition, with the building up of scientific habits of thought.

The experiences offered so far have been challenging to the children, an essential condition. Only thus will the full energies of the children be utilized and the full measure of success in teaching be attained.

Lois Meier Shoemaker,
New Jersey State Teachers College at Trenton

THE ASSOCIATION OF SCIENCE TEACHERS OF THE MIDDLE STATES

The fifteenth annual meeting of the Association was held in the Music Room of the Hotel Chalfonte, Atlantic City, November 30, 1935, with Dr. S. R. Powers in the chair. With some introductory remarks by the President, the program as published was begun at nine o'clock, as follows:

This program is devoted to consideration of the functions of science teaching in general education and to consideration of the ways used to accomplish these functions in city and state systems.

A. *What are the plans for meeting the needs of general education in science in secondary school systems?*

1. *What is the program and what changes are anticipated in the State of New York?* Dr. Warren W. Knox, Supervisor of Science, New York State Department of Education.
2. *What is the program and what changes are anticipated in the State of New Jersey?* Mrs. Pauline McDowell Atkins, Supervisor of Science, Elizabeth, N. J.
3. *What is the program and what changes are anticipated in the City of Philadelphia?* Dr. E. E. Wildman, Supervisor of Science Education, Philadelphia, Pa.
4. *What is the program and what changes are anticipated in Washington?* Dr. Ellis Haworth, Supervisor of Science, Public Schools, Washington, D. C.
5. *What is the program of the Commission on Secondary School Curriculum?* Mr. H. Emmett Brown, Lincoln School, Teachers College, New York City.

Discussion from the Floor

B. *What are the plans for meeting the needs of general education in science in colleges?*

1. *Some interpretations of practices in the organization of courses of the survey type.* Dr. R. J. Havighurst, General Education Board, New York, City.
2. *What is being attempted in courses of the survey type at Colgate University?* Professor Eugene G. Bewkes, Colgate University, Hamilton, N. Y.
3. *What is being attempted in courses of the survey type at Darmouth College?* Professor J. P. Poole, Dartmouth College, Hanover, New Hampshire.
4. *What is being attempted in courses of the survey type in the education of*

teachers, particularly in Connecticut? Mr. O. E. Underhill, Teachers College of Connecticut, New Britain, Conn.

Discussion from the Floor

Report of the Committee on Policy Planning for Long-Term Service by the Association.

Report of the delegate to the meeting of the American Association for the Advancement of Science Committee on Place of Science in Education. Mr. Earl R. Glenn, State Teachers College, Montclair, N. J.

Business Meeting

Luncheon, Blue Room, Hotel Chalfonte. (No program scheduled, but there will be opportunity for continuing the discussion of points that arise out of the morning meeting.)

On part A, the speakers presented the order of development of the science subjects in the respective state and city systems, analyzed present conditions, and suggested plans for the future.

Dr. Knox spoke for New York, emphasizing matters of "general education," of sequence, integration, college entrance. The latest part of the state program is the six-year elementary program.

In New Jersey, Mrs. Atkins stated that there is no state program, every program being in the hands of the local authority. A state survey of the Junior High School field was begun under the leadership of Merwin M. Peake of Elizabeth. Mrs. Atkins presented some of the items from the report dealing with pupil percentages and teacher limitations. She presented conditions in the senior-high-school field and outlined difficulties for future work.

Dr. Wildman set forth the aims of the science program in Philadelphia. He emphasized the need for research in this field and inveighed against the injustice to the pupil in the way of character-building when careless or lazy work is accepted for promotion or credit.

Dr. Haworth reviewed the history of the reorganization of science instruction in Washington, D. C., along more functional lines, following particularly the recommendations of the Thirty-First Yearbook of the N. S. S. E. He outlined the needs of getting the plans of supervisors into the hands of the classroom teachers. He discussed the correlation between the science program and a character education program carried on in Washington in 1934.

A tentative report on the work of the Thayer Commission on Secondary School Curriculum (under the Progressive Education Association) was presented by Mr. Brown of the Lincoln School of Teachers College, Columbia University, and a member of the Commission. He said that what he reported should be regarded in the light of suggestions only for curriculum workers.

In the general discussion that followed a vigorous plea was made for "ruthless pruning of subject matter to get time for development of suspended judgment.

In Part B of the program, dealing with plans for meeting the needs of general education in science in colleges, Dr. Havighurst opened the discussion with a statement of the principles of organization of survey courses in the natural sciences as determined from an analysis of a study made of approximately 75 liberal arts colleges and an estimated 50 teachers colleges and a smaller number of junior colleges.

The next three papers presented reports of practices at Colgate University by Professor Bewkes, at Dartmouth College by Professor Poole, and at Connecticut Teachers College by Mr. Underhill. Each speaker traced the development of the origin and organization of the respective survey courses, and detailed the content of the courses. It was brought out forcibly that the criticism of superficiality is not warranted.

The interesting discussion from the floor, participated in by a considerable number of members, centered about the justification for the courses and their meeting a "basic human need" in the general education of every college man and woman.

A telegram was read from Mr. Glenn, representative of the A. S. T. to A. A. A. S. Committee on Place of Science in Education, stating that copies of his paper read December, 1934, and the program of the coming St. Louis meeting would be mailed to members. A vote of confidence was given Mr. Glenn.

The report of the nominating committee was read by Miss Rhea Baker. As no nominations were made from the floor, the slate as presented was, on motion duly made and seconded, declared elected. The officers for 1936 are as follows:

President—Mr. Clarence E. Feick, Head of Science Department, South Philadelphia Boys' High School, Philadelphia.

Vice-President—Mr. Merwin M. Peake, Lafayette Jr. High School, Elizabeth, N. J.

Secretary-Treas.—Miss Dena D. Ungemach, Head of Science Department, Overbrook High School, Philadelphia.

Council—Dr. S. Ralph Powers, Professor of Natural Sciences, Columbia University, New York City.

Dr. Ellis Haworth, Supervisor of Science, Public Schools, Washington, D. C.

Miss Elizabeth W. Towle, Head of Science Department, Baldwin School, Bryn Mawr, Pa.

Dr. Robert Kunzig, Head of Science Department, South Philadelphia Girls' H. S., Philadelphia.

The report of the Committee on Policy Planning for Long-Term Service by the Association, Dr. Haworth, chairman, was presented and adopted according to the following four points. The discussion was carried over to the luncheon.

1. Function of the organization: the study of the place of science in the program of general education and the problems relating thereto.
2. A Publication Committee to be appointed (3 or more persons).

a. An official journal.
b. Obtaining reports of significations activities.
c. Publicity for the Association.

3. A Planning Committee to be appointed (7 persons)
   a. Possible problems for discussion
      1. What shall we teach — grade placement, organization, integration, specialization (where begun)
      2. What are the values of the survey course and where shall it be given?
      3. What should be the training of science teachers (undergraduate and in-service)?
      4. Is laboratory work (individual) justifiable?
      5. Problems in developing a continuous science program.
   b. Co-ordinating work of local and state groups with the program of the Association.
4. Dues to be raised next year to $2 (to be voted on next year, according to Constitution)

TREASURER'S REPORT, NOVEMBER 30, 1935

Receipts

Balance on hand 11/28/34	$127.90
Dues received 12/1/34 to 11/28/35	57.00
Interest	3.12
	$188.02

Disbursements

Luncheon 12/1/34	$ 5.00
Postage, printing, clerical service	17.50
Telegrams, telephone	1.25
Appropriation authorized for 11/30/35	60.00
	$ 83.75
Balance on hand 11/30/35	104.27
	$188.02

The report was accepted and ordered filed.

At the luncheon the new President, Mr. Feick, was introduced. He expressed gratification at the splendid meeting and asked for co-operation for the next administration. The meeting adjourned at 3 o'clock.

Respectfully submitted,
DENA D. UNGEMACH,
Secretary-Treasurer.

A meeting of the Executive Committees of both 1935 and 1936, as moved by Dr. Q. Drake, was held immediately following the main meeting. Committees on Publications and on Policy Planning were appointed. This meeting adjourned at 3:45 P. M.

DENA D. UNGEMACH,
Secretary.

PROGRAM OF THE NINTH ANNUAL MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

ST. LOUIS, MISSOURI
FEBRUARY 23, 24, 25, 1936

Headquarters: Hotel Statler

Executive Committee

GERALD S. CRAIG, *President*
W. G. WHITMAN, *Vice-President*
S. RALPH POWERS, *Secretary-Treasurer*
IRA C. DAVIS
ARCHER W. HURD

(For information about SCIENCE EDUCATION, the official Journal of this Association, communicate with Clarence M. Pruitt, Colorado State College of Education, Greeley, Colorado.)

Sunday, February 23, 1936
Hotel Statler—Daniel Boone Room

Dinner Meeting 6:30 P. M.—For Members Only
Gerald S. Craig, Presiding
Report of the Executive Committee.
W. G. Whitman, Chairman.
Report of the Committee on Constitutional Revison.
Edward E. Wildman, Chairman.
Report of the Committee on Rotation and Tenure of Office.
Hanor A. Webb, Chairman.
Report of the Committee on Publications.
Elwood D. Heiss, Chairman.
Report of the Committee Cooperating with the A. A. S. Committee on the Place of Science in Education.
Harry A. Carpenter, Chairman.
Report of the Committee to Draw up a List of Active Investigators in the Field of Science Education.
Victor H. Noll, Chairman.
Report of the Program Committee.
C. L. Thiele, Chairman.
General Discussion of Policies, etc.

Monday, February 24, 1936
8:30 A. M.
Hotel Statler—Room 106
Report of the Committee on Five.
Ralph K. Watkins, Chairman.
Report of the Sub-Committees of the Committee of Five:
Committee on Elementary School Curriculum.
Florence G. Billig, Chairman.
Committee on Secondary School Science.
Ellsworth S. Obourn, Chairman.
Committee on Junior College Science.
Palmer O. Johnson, Chairman.
Committee on the Education of Teachers.
Ralph K. Watkins, Chairman.
Committee on Scientific Attitudes.
Francis D. Curtis, Chairman.

A Program of Research in Science Education at the Senior High School and the Junior College Levels.

Curriculum Research. S. Ralph Powers, Teachers College, Columbia University, New York.

Research in the Learning Process. Anita D. Laton, University of California, Berkeley, California.

Business Meeting.

Report of Nominating Committee and Election of Officers.

Report of Committee on Resolutions.

Unfinished Business.

Committee meetings.

Tuesday, February 25, 1936
8:30 A. M.
Hotel Statler—Room 106
Gerald S. Craig, Presiding

The Effects Produced by Different Methods of Instruction in Elementary Science.
Wilbur L. Beauchamp, University of Chicago, Chicago, Illinois.

Evaluation of the Schools of the Aiken Commission.
Fred P. Frutchey, Bureau of Educational Research, Ohio State University, Columbus, Ohio.

A Basis for the Selection of Course Content in Elementary Science.
Martin L. Robertson, School of Education, New York University, New York.

The Wisconsin Science Committee Plan for Research.
Ira C. Davis, School of Education, University of Wisconsin, Madison, Wisconsin.

SEVENTEENTH ANNUAL MEETING OF THE NATIONAL COUNCIL ON ELEMENTARY SCIENCE

February 22, 1936
Adam Room, Hotel Statler, St. Louis, Missouri

FORENOON SESSION

9:30—*Science in the Eugene Field School.*
L. M. Dougan, Principal, Eugene Field School, St. Louis, Missouri.

9:55—*Recent Developments in the Science Course in Austin.*
Vesta C. Hicks, Department of Sciences, Austin Public Schools, Austin, Texas.

10:20—*A Unit in Science for Grade Five.*
Glenn O. Blough, Lincoln Consolidated Training School, Michigan State Normal College, Ypsilanti, Michigan.

10:45—*The Integration Unit System in the Teaching of Elementary Science.*
Mrs. Emily Barry Walker, Supervising Teacher of Elementary Science, East Texas State Teachers College, Commerce, Texas.

11:05—*Research Regarding Attitudes.*
Dr. Otis W. Caldwell.

11:30—*Informal Discussion.*

12:00—*Luncheon Meeting.*
Guest speaker, Dr. George T. Moore, Missouri Botanical Garden, St. Louis, *On Being Scientific.*

AFTERNOON SESSION

2:00—*Some Peculiar Nesting Habits of Birds.*
Henry M. Kennon, Curator of Birds, St. Louis Zoological Park.

2:30—*Symposium: Progress in the Teaching of Elementary Science.*
Gerald S. Craig, Teachers College, Columbia University, New York City; Ira C. Davis, University of Wisconsin, Madison, Wisconsin; Theodosia Hadley, Western State Teachers College, Kalamazoo, Michigan; Jennie Hall, Adviser in Science, Minneapolis, Minnesota; G. W. Haupt, State Teachers College, Westfield, Massachusetts; Lillian Hethershaw, Drake University, Des Moines, Iowa; Allegra Ingleright, Director of Elementary Education, South Bend, Indiana; Mildred Fahy, Principal, Peirce School, Chicago; Mary Melrose, Supervisor of Elementary Science, Cleveland, Ohio; Geraldine Shontz, State Teachers College, Terre Haute, Indiana.

4:00—*Business Meeting for Members Only.*

NEW YORK SCIENCE TEACHERS ASSOCIATION

The following report of the meeting of the New York Science Teachers Association has been received from Louis J. Mitchell, secretary of the Association:

The annual meeting of the New York State Science Teachers Association attracted to Syracuse the largest attendance in the history of the organization. This record turnout was an index of a felt need on the part of the science teachers for a more integrated science organization in this state.

The state science teachers registered a strong sentiment against the action of certain zones which have endeavored to eliminate the subject sections of the zone meetings. Records show that nearly 2,000 science teachers attend the various zone meetings. These meetings are regarded as very helpful to the classroom teacher. Teachers who had attended the general meetings substituted for the subject section meetings stated that the program dealt largely with administrative problems.

The Association agreed that they would like to support one comprehensive national science

teachers association and deplored the duplication in this field. The members felt that such an association might become comparable to the American Medical Association. They further agreed that such an organization should have an official publication, making use of those already in the field, and covering the grades from one to twelve.

The Board of Directors provided for a committee to undertake the actual preparation of suggested syllabuses for all science activities in the state from grades one to twelve. The committee will assume the duties of planning, constructing, and experimenting with new units of work. The purpose of this committee is to readjust the science program to meet the needs and philosophies of progressive education for the child and to provide a really integrated science sequence and curriculum.

The establishing of a clearing house to acquaint the science teacher with material that will be helpful to him in teaching will be of inestimable value to the teacher in the smaller high school. The committee plans to pool such science material as may be contributed and to disseminate it as a part of the science letter to be distributed to the teachers at the zone science sectional meetings.

The program, with its emphasis on the theme, "Science Through Pupil Activity," gave the science classroom teacher valuable information that had immediate application in the classroom. The main speakers on the program were Dr. Warren W. Knox, State Supervisor of Science, Dr. P. W. Zimmerman, plant physiologist and assistant director of the Boyce Thompson Institute for Plant Research, and Dr. Morris Meister, Chairman for the New York City Student Science Fair, who pointed out the advantages of student science clubs.

Reports on practical student activity were given by Mr. E. L. Osborn of Hudson Falls, Mary Nelson of Boonville, Francis Almstead of Clinton, and William B. Sanford of Painted Post.

The following officers were elected: *President,* F. T. Mathewson, East View Junior High School, White Plains, New York; *Vice President,* Theodore Shull, Valley Stream High School, Valley Stream, New York; *Secretary-Treasurer,* Louis J. Mitchell, Dansville Central High School, Dansville, New York.

The Directors selected at large for three years were: K. M. Humphrey, Vocational High School, Syracuse, New York; Edward L. Osborn, Hudson Falls High School, Hudson Falls, New York.

NEBRASKA SCIENCE TEACHERS ASSOCIATION

Our readers will be interested in the plans proposed for improving the teaching of science in Nebraska as reported by Mr. Wise, secretary of the Board of Directors of the Association:

The semi-annual meeting of the Board of Directors of the Nebraska Science Teachers Association convened in Teachers College, University of Nebraska, on Monday, December 23, 1935. Mr. E. H. Schroer, Benson High School, Omaha, presided in the absence of the president, Dr. P. G. Johnson, who is on leave of absence from the University of Nebraska. Fifteen members, including the chairman of each science section of the Nebraska State Teachers Association, the chairman of the High School Section of the Nebraska Academy of Sciences, and other leading science teachers from over the state, were present. Business considered by the Board included: (1) Planning the program of the spring meeting of the Science Teachers Association, which will be held in conjunction with the Nebraska Academy of Sciences convention; (2) planning for the coordination of the science section programs of the State Teachers Association next fall; (3) the preparation of a list of acceptable science speakers for general session meetings, the list to be presented to officers of the Nebraska State Teachers Association; (4) reports of membership and research committees; (5) election of officers for the coming year.

The Research Committee, Mr. Harold E. Wise, Department of Secondary Education, University of Nebraska (chairman); Miss Mary Sturmer, Beatrice, Nebraska; and Mr. G. J. Chamberlain, of Grand Island, Nebraska, reported the launching of a state-wide research project, which seeks to effect a compilation of classroom techniques and procedures which different teachers have found to be effective in meeting the problem created by excessively large science classes and too many teaching periods per day. It is the plan to place this material in the hands of each member of the Association, and others who contribute to the success of the project.

Officers elected are as follows:

President: Mr. Lawrence M. Dye, Senior High School, Scribner, Nebraska.

Vice-President: Dr. James Brock, State Teachers College, Wayne, Nebraska.

Secretary: Mr. Harold E. Wise, Department of Secondary Education, University of Nebraska, Lincoln, Nebraska.

Treasurer: Mr. E. K. Bauman, Senior High School, Alliance, Nebraska.

Science Editor: Mr. J. J. Guenther, Technical High School, Omaha, Nebraska.

The Nebraska Science Teachers Association was organized during the school year 1934–1935. It seeks to coordinate the activities of the various science sections of the Nebraska State Teachers Association and of the High School Section of the Nebraska Academy of Sciences. The objectives of the Association are:

1. To make available authentic information; the results of research in science education.
2. To promote the development of science materials and methods leading to the advancement of science in the schools of Nebraska.

3. To promote more adequate training of science teachers for all pre-college levels.
4. To promote a spirit of good fellowship among science teachers.

OCCUPATIONAL INDEX

The following release from the National Occupational Conference will command the attention of many science teachers:

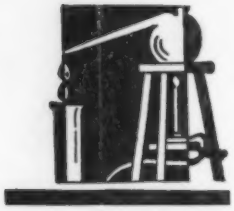
A NEW SERVICE, providing a guide to current literature describing occupational opportunities, requirements, and trends, begins today with the appearance of the *Occupational Index*, prepared and published by the National Occupational Conference, 551 Fifth Avenue, New York. The Conference is a research organization supported by the Carnegie Corporation.

Through correspondence with 500 industrial organizations, professional associations, and research workers, and through examination of 100 magazines and all new books, the Conference will compile each month an annotated and classified bibliography of occupational information useful for purposes of vocational guidance and vocational education. This will be published in periodical form and distributed monthly to subscribers. A special grant from the Carnegie Corporation enables NOC to offer the service at a subscription rate of five dollars a year.

AN EXTENDED SCIENCE PROGRAM

Working with support from the General Education Board, the department of Natural Sciences at Teachers College, Columbia University, is extending its work in the development of a science program suitable to the needs of general education. Four research associates, working with assistance from regular members of the staff, are giving full time to the work. Projects in progress or to be initiated shortly include: (1) the development of source materials for use by curriculum workers, and (2) school room experimentation. These projects are under the immediate direction of Professor S. R. Powers.

Abstracts



GENERAL EDUCATION

McCall, William. "My Philosophy of Life and Education." *Teachers College Record* 37: 50–59; October, 1935.

In this article Dr. McCall presents the fourth of a series of theses on his philosophy of life and education. In many respects these theses have been among the very best articles that have appeared in the Record. The author presents and discusses the following theses: (1) purpose begets ability; (2) there are special methods which will assist a purpose to generate an ability; (3) purpose selects the right response or ability; (4) clear, intrinsic pupil purposes make for accurate selection; (5) the permanence of an ability is proportional to the volume of neural energy that has flowed through an ability's synaptic series; (6) purpose, if adequate, assures permanence of ability; and (7) Thorndike's psychology of learning is primarily a psychology of learning abilities. —C.M.P.

Williams, Joseph E. "Success of Semiprofessional Curricula." *The Junior College Journal* 6: 77–82; November, 1935.

This article reports the results of a questionnaire sent to all the graduates of the semiprofessional curriculum of the Los Angeles Junior College. Replies from 285, or 56 per cent, of the graduates are summarized in part in these conclusions: "The graduates who replied to this inquiry indicate that 65 per cent of them are employed and that 62 per cent are following the work for which they were trained in school. This is significant in this period of economic depression and points to the fact that the junior college curriculum should be flexible and ever-sensitive to the changing needs of the community which it serves. Only 14 per cent indicate that they are following work which is of trade character. The earnings center about sixty to eighty dollars a month with many earnings from one hundred to one hundred and twenty dollars, and a few with higher incomes." —F.D.C.

Davis, Calvin O. "The Evolution and Significance of the American High School." *The High School Teacher* 11: 99–100; 117–188; April, 1935.

This article is an historical resumé of the growth of the American High School by an author who has been associated with this growth for many years. The change in ideals, purposes, and functions that has taken place along with the expansion in numbers and size is well emphasized. The typical high-school teacher knows too little concerning the institution in which he works. Many teachers are out of step with the institution in which they work because of an ignorance of the pattern of growth of American education and educational ideals. Curriculum dabblers continue to dabble with no clear notion of the nature of the general setting in which their products must be made to operate. This brief history of the American High School is recommended to the reading of all high-school teachers. —R.K.W.

Wetzel, William A. "Forty Years a Schoolmaster." *Bulletin of the Department of Secondary-School Principals of the National Education Association* 57: 9–42; May, 1935.

Do not pass this by with the notion that it is the biographical reminiscence of a retiring schoolmaster. This is the concrete story of the growth, change, and development of a large high school told in terms of concrete evidence and graphical presentation of pertinent data. As in the beginning, "Then fewer than 10% of the pupils of secondary-school age were in school. Today 60% of all children up to eighteen years of age are enrolled in school, and the other 40% should be so enrolled." Certain sections are of special significance. Some of these are the summary of things aimed at in the last 10 or 15 years at the Trenton (New Jersey) High School; the list of unfinished business left as a record for the successor; and the summary of "What I should do if I were going to remain as the principal of the Trenton High School for the Next Ten Years."

This is a stimulating story of high adventure for all school people. The proposals for the future are challenging. Every high-school principal should read this, and when the principal has finished the bulletin, it should be made available to all the teachers in his school. —R.K.W.

Reports Relating to the General and Specialized Subject-Matter Preparation of Secondary School Teachers. *North Central Association Quarterly* 10: 219–255; October, 1935.

These reports were made at the meeting of the North Central Association of Colleges and Secondary Schools last April. They give factual evidence on factors involved in the success of high-school teachers, subject-matter preparation

of high-school teachers, combinations of teaching subjects, curriculum trends, and trends in subject-matter preparation of high-school teachers.

—A.W.H.

STUDEBAKER, JOHN W. "Should Educational Organizations Safeguard Freedom of Thought and Instruction in American Schools." *Phi Delta Kappan* 18: 76–79; November, 1935.

The United States Commissioner of Education presents a forceful plea for a positive attitude on the part of teachers with regard to the social problems of our civilization. The alternative is a control and rigid censorship of the educational system and suppression of freedom of thought and instruction. ". . . it should be the *primary* concern of our professional educational organizations to safeguard *our* educational system from the straight-jacketing influences of *these* alien doctrines of suppression and censorship."

—O. E. UNDERHILL

ZOOK, GEORGE F. "Junior College: Dependent or Independent?" *The Junior College Journal* 5: 432–436; May, 1935.

The author concludes his able plea for interdependence with this statement, "We ought . . . in cooperation with the schools on the one hand and the four-year colleges on the other to recognize the interdependence of our interests and obligations in the solution of our great national youth problem."

—F.D.C.

SCIENCE EDUCATION—GENERAL

GRUENBERG, BENJAMIN C. "Science and the Layman." *Scientific Monthly* 40: 450–457; May, 1935.

The author advances the thesis that "science as a method of dealing with ever new problems or with old problems in new settings must be democratized, must be removed from the exclusive custody of specialists, must be assimilated by the entire population and made a part of the common life."

Evidence indicates that there has been a decline of science in adult education during the last half century. About five or six per cent of adult education activities relate to science. Much of the popularization of science for adults is closely related to technical or vocational instruction. There is an increasing tendency on the part of those furthering the development of science in adult education: (1) to value increasingly the hobby interest or the personal curiosity motive; (2) to demand more participation or activity on the part of the "learners" as against purely verbal instruction; (3) to lay more emphasis upon interpretational as against informational effort; (4) to attach increasing importance to cultural outlook and the development of appreciations and to the consideration of the social implications of the domination of science in our lives.

—C.M.P.

NOLL, VICTOR H. "The Extent of Chemical Education." *Journal of Chemical Education* 12: 475–481. (October, 1935)

This is a contribution to the symposium on The Rôle of Chemistry in Education conducted jointly by Section C (Chemistry) and Section Q (Education) of the American Association for the Advancement of Science, Pittsburgh, December 27, 1934. Chemistry was offered as a separate branch of instruction in King's College in 1767 and in the academies as early as 1810. Chemistry had a relatively slow growth, probably reaching its maximum development between 1875–1890 in so far as the percentage of students enrolled and the number of high schools offering. Since 1910 the percentage of students taking chemistry has remained constant, 7.3 per cent being enrolled in 1928. However, between 1890 and 1928 the number of students taking chemistry has increased from 63,644 to 230,020—an increase of 800 per cent.

The article also discusses the extent to which chemistry is offered in junior colleges, teachers colleges, arts colleges, universities, and professional schools. The author states that it is probably true that "chemical education is proportionately better represented on the higher academic levels than it is in lower schools—with probably 440,000 students (on all levels) taking chemistry during the regular academic year."

HOWERTH, I. W. "Popular Indifference to Science?" *The Phi Delta Kappan* 17: 191–196; April 1935.

Popular indifference to science arises because of the conception that science is something remote from popular interest and beyond the reach of the popular mind. This indifference may be removed by a recognition of what science is rather than what scientists sometimes say it is. Scientists are apt to define science in terms of accumulated results, or in terms of method alone. By implying that it is something with which scientists alone are concerned the result is a defense reaction on the part of the common people in which they contrast common sense with science and tend to prefer the former if the two seem to clash. After amplifying the above view somewhat the author discusses the factors in common between the scientist's procedure in discovering truth and the common individual's method of applying common sense to his problems. Respect for scientific method is to be developed by teaching the young its value in solving the problems of life. Popularization of science is often taken, particularly by scientists, in an undesirable sense but it is necessary to arouse interest and very difficult to do it well. Opposition comes chiefly from scientists who themselves are flat failures in their efforts to

make themselves popularly intelligible. The scope of science must also be extended and the scientific method of attacking problems be applied in social and economic fields.

The article, which the reviewer has tried all too briefly to summarize, is well worth reading in its entirety. —O. E. Underhill.

Drake, William E. "The Need for A Scientific Attitude." The *High School Journal* 18: 229–232, 242; November, 1935.

In the schools special emphasis should be put upon scientific attitudes. Social problems which face our present civilization are clearly defined, and the danger to democratic institutions of failure to develop scientific attitudes is pointed out. "One great difficulty we have today is a great lack of critical evaluation and thinking—a lack of scientific attitude of mind which seeks the truth, and tests the practical value of that part of it which we think we have discovered." The emphasis today is on propaganda aimed at keeping people loyal and true to old forms and institutions. "One of our great hopes would seem to be in the direction of extending to social and civic fields our scientific attitudes and techniques. In the social field we are about where the scientist was 250 years ago." Three criteria of scientific attitude as given by Bertrand Russell are "(1) the individual uses observation and induction, not intuition. (2) he places his reliance upon persuasion and not upon force. (3) he persuades by arguments based upon tested evidence." —O. E. Underhill.

Thorpe, Louis P. Education and Naive Belief. *Phi Delta Kappan* 18: 79–82; November, 1935.

" . . . man possesses a profound capacity for naive belief. . . . He displays no apparent compunctions against believing the 'thousand and one' loose generalizations touching on all phases of life which are, as it were, floating around, in popular parlance.

"The fact that many of these assumptions are totally devoid of foundation in terms of objective evidence seems to act as no inhibition to easy acceptance. In fact civilized men as a unit have not yet reached the place of educated sophistication necessary for even a cursory realization of the profound value of that critical point of view which extols verifiable procedures and the suspension of judgment pending objective proof. Uncritical acceptance of indoctrinate beliefs has been and still is the vogue."

The rigidity and formality of some educational practices, the formal nature of much curriculum material, especially on the secondary level, and the harsh attitude of many towards adolescent youth may, in large part, be traced back to beliefs of the medieval church as to the nature of the child. At the opposite extreme, educational practices of more recent development are based upon an opposite conception of child's original nature having its origin in the philosophy of Rousseau and his followers. Both the doctrine of original sin and that which assumes the child's innate goodness are generalized assumptions which too often are not examined critically. There is a small third group who consider the child neither good nor bad but as a human organism possessing wants, needs and drives, but originally neutral as far as moral ideas are concerned.

Professor Thorpe's analysis of the characteristics of these three groups and the relationships of these philosophies to educational practices is interesting and thought-provoking.

—O. E. Underhill.

Compton, Karl T. "Science for the Layman." *The Science Leaflet* 9: 450–453, December 12, 1935.

This is a radio talk given by Dr. Compton to members of the Student Science Clubs of America. Dr. Compton reviews the slow development of science and the reasons for this, the present status of scientific research, and some of the present unsolved problems in science.

—C.M.P.

Hopkins, B. S. "The Cultural Value of Chemistry in General Education." *Journal of Chemical Education* 12: 418–422; September, 1935.

Since the classics no longer hold the place of greatest importance in our educational program, other subjects must be taught for cultural values, as well as for more utilitarian values. Chemistry is one which should contribute definitely to both the cultural and the practical aims of modern education. Chemistry has disciplinary value and at the same time it touches upon countless aspects of daily life. —V.H.N.

Silverman, Alexander. "The Prerequisite and Collateral Value of Chemistry." *Journal of Chemical Education* 12: 422–428; September, 1935.

Chemistry and chemical knowledge play an important role in most professions and in many other vocations. The engineer uses and must know something of chemistry to be successful. Medicine and dentistry are to a large extent dependent upon chemists and chemical research. The biologist, the bacteriologist, the business man, the lawyer and the journalist all profit by the work of the chemist bearing directly upon the work in which they are engaged.

—V.H.N.

Harding, T. Swann. "What Is Scientific Proof?" *Scientific American* 153: 192–194; October, 1935.

Scientific proof is not based upon casual and fortuitous associations of events. "Post hoc ergo propter hoc" is one of the most respectable and almost the most unavoidable fallacy. Scientific proof means the isolation of one factor which can be varied, while all other factors are held constant. Scientific proof is thus most difficult to establish. —C.M.P.

SCIENCE IN ELEMENTARY SCHOOLS

HAUPT, G. W. "Grade Placement in Elementary School Science." *School Science and Mathematics* 35: 858–864; November, 1935.

This article presents an analysis of three procedures in grade placement of subject-matter: "(A) Vary the aim of instruction in different grade levels; (B) Treat different sciences on lower and higher grade levels; and (C) Integrate content from all of the sciences by means of an objective and grade the contributory content on the basis of its progressive complexity." The analysis was followed by post instructional tests, the results of which were analyzed. From the analysis of the results of these tests the conclusions emerge which "may be used as criteria for guidance in grade placement": "(A) The concepts needed for the associations which were made on the lower grade levels depended upon few experiences which were easily given and acquired; (B) The concepts needed for the association which were made on the higher levels depended upon series of experiences which were not so easily presented or acquired, and (C) more concepts were associated in the elemnts of the higher grade levels." —F.D.C.

PALMER, E. LAURENCE. "Teachers Number." *Cornell Rural School Leaflet* 29: 3–63; September, 1935.

The September 1934 *Cornell Rural School Leaflet* includes teaching helps on the elementary science material to be taught during the years 1934, 1936 and 1938, in grades two, four, and six. This number of the *Leaflet* does the same for grades one, three and five for the years 1935, 1937 and 1939. In New York state a defintely planned elementary science program of two-year sequence is now in effect. This number of the *Leaflet* presents suggested helps on the following units: Fall —space measurements and mastery, food problems; Winter—sound, weight, magnetism and electricity, energy transfer; Spring—origins and ancestry, signs of intelligence. A bibliography of books for nature study and science is included. —C.M.P.

SCIENCE IN SECONDARY SCHOOLS

WEBB, HANOR A. "The High School Science Library for 1934–35." *Peabody Journal of Education* 13: 57–67; September, 1935.

The author's annual review of the books suitable for the science division of the high school library. Reviews are very short but pointed. Complete data needed for purchasing each book is given. Books are classified on a price basis. For example, if you have only ten dollars to spend for books, this book should be included. Reprints may be purchased from the author for ten cents each. Address George Peabody College for Teachers, Nashville, Tennessee. Science teachers who have been keeping a file of these lists will need this one to keep the file up to date. Other teachers should begin a file with it. —R.K.W.

PRESTON, CARLTON E. "The Science Column." *The High School Journal* 18: 202–204; October, 1935.

Continuing with his series of discussions of the texts adopted by the state of North Carolina, Mr. Preston makes a pertinent analysis of the function of physics in the secondary school curriculum. Teachers of physics may limit their classes to the few who are interested in mathematics and the abstract, plus those who for one reason or another wish to meet some particular college requirement, or "seek to make physics genuinely attractive to average students not headed for college . . . interested . . . in the common things of everyday life, measuring the value of their various school subjects in terms of the number of their perceived applications in the work of the world that they know." There is a great difference in studying how a thing works and how much it works. Emphasis should be on a qualitative rather than a quantitative approach. Numerical work is not to be completely omitted but to be used as means to an end. Quantitative concepts may be developed without necessitating too much emphasis on drill, mathematical detail, and percentage error. —O. E. Underhill.

A Symposium, "Principles and Organization of High School Mathematics." *California Journal of Secondary Education* 10: 543–559; December, 1935.

This symposium contains the following discussions: "Functional Mathematics" by C. C. Trillingham; "Future Developments in Junior High-School Mathematics," by Willa M. Marsh; "Mathematics Instruction in Junior College," by Frank B. Lindsay; "Mathematics and General Education" by Merton E. Hill; and "Adequate Training of Teachers of Mathematics," by L. J. Adams. —F.D.C.

MACNEIL, WILBUR J. "Physics Demonstrations on the Commencement Program." *School Science and Mathematics* 35: 911–914; December, 1935.

This is an interesting account of pupil projects in which were made apparatus by means of which to demonstrate the principles of the dynamo, motor and transformer and the relations of these machines to each other. Apparatus secured mostly from junk yards was assembled by the pupils into completed machines which were demonstrated by the boys as part of the commencement program. —F.D.C.

Frank, J. O. and Lundsted, Lester. "Historical Materials in High-School Chemistry Texts." *Journal of Chemical Education* 12: 367–369; August, 1935.

An analysis of twenty most widely used textbooks in high-school chemistry reveals that there is no substantial agreement as to the amount or kinds of historical materials to be included. The amount of material ranges from a total of 132 words in one book to 4030 in another. The number of portraits ranges from none to thirty. No book attempts to present a connected discussion of the history of chemistry. Most of the books present some historical cuts, mention names in connection with important discoveries, and make some sporadic references to alchemy and the origins of modern chemistry. —V.H.N.

Schultz, M. P. "Selection of a High-School Chemistry Text." *School Science and Mathematics* 35: 915–922; December, 1935.

This study outlines a method of selecting a textbook on two bases: (1) the readiness with which pupils are able to comprehend its discussions and (2) the distribution throughout the book of arithmetical problems with relation both to initial practice in solution and to subsequent reviews. Objective tests of comprehensibility were administered to five roughly equated groups of pupils. The results of the study indicated that the method employed reveals differences in comprehensibility and in distribution of problem practice and that it therefore offers a useful basis for text selection. —F.D.C.

Naden, J. L. "An Experimental Study of the Relative Values of a Direct and an Indirect Method of Teaching Study Habits in Science." *School Science and Mathematics* 35: 970–976; December, 1935.

This is the report of a carefully controlled learning study with two groups of general science pupils both of which were given the same training in study habits, but the experimental or direct-method group was urged to apply these techniques in their daily preparations while the control or indirect method group were not so urged. Statistical treatment of the data revealed the rather surprising result that with respect to immediate recall of subject-matter slight but not statistically significant advantages were revealed by the scores of the control or indirect-study group. —F.D.C.

Symposium: "Food; The States of Matter; The Bodies of Lower Plants." *The Science Leaflet* 9: 329–367; November, 14, 1935.

This number of *The Science Leaflet* discusses the above mentioned three topics in the three science fields; chemistry, physics, and biology. —C.M.P.

Symposium: "Transportation." *Building America* 1: 2–28; December, 1935.

Building America is a photographic magazine of modern problems. This particular issue is given to the problem of transportation. Through pictures and words it tells how our nation built a great system of waterways, railroads, highways, and air routes. The magazine is heartily recommended to science teachers and school libraries. —C.M.P.

Wailes, Raymond B. "The Chemical Triplets." *Popular Science Monthly* 127: 52–53; 114; November, 1935.

The article describes interesting experiments with compounds of the elements barium, calcium and strontium. —C.M.P.

Wailes, Raymond B. "Molecules in Action." *Popular Science Monthly* 127: 52–53; 119–120; December, 1935.

A series of simple experiments for demonstrating molecular motion are described in this illustrated article. —C.M.P.

SCIENCE IN COLLEGES

Day, Jesse E. "University Recognition of Proficiency in High-School Chemistry." *Journal of Chemical Education* 12: 166–168; April, 1935.

The first half of this article recounts briefly some of the earlier attempts by universities to grant advanced standing to students for proficiency in high-school subjects. The remainder of the article describes the methods used at Ohio State University to examine students who wish to obtain credit in college chemistry for work done before they matriculate. Two examinations, one covering knowledge of chemical facts and principles, and one on laboratory techniques, are used. Of a total of about 600 taking placement examinations in chemistry, 77 were permitted to take the proficiency examination for advanced standing. Of these, 32 passed and were permitted to progress faster than the others. Only two of these appeared subsequently to be unable to do this. —V.H.N.

Smith, Otto M. "Accepted Objectives in the Teaching of General College Chemistry." *Journal of Chemical Education* 12: 180–183; April, 1935.

The results of a questionnaire study including land grant colleges, universities, colleges, and authors of textbooks in chemistry. The aims of a course in general college chemistry as obtained through this study include almost exactly the same things usually started as objectives of the high school course. The aims, as stated by the various respondents, and the proportions checking each one as essential or desirable, are given in tabular form. —V.H.N.

CREIGHTON, J. JERMAIN. "Honors Work in Chemistry at Swarthmore College." *Journal of Chemical Education* 12: 260–264; June, 1935.

At Swarthmore College a student may take a degree "in course" or "with honors" in the department of chemistry. In the latter case he takes the regular courses for the first two years and, if by that time he shows himself capable of it, he takes honors work for his last two years. The two outstanding features of this type of work are, first, the freedom and independence of the student, and second, the system of examinations. The work usually consists of weekly seminars and considerable laboratory work. The examinations are written and oral. The written examinations are set by instructors at other institutions, and the oral examinations are conducted by the students' own instructors. —V.H.N.

HILL, LYLE O. "Results of a Short First-Year College Course for Students Who Have Had High School Chemistry." *Journal of Chemical Education* 12: 323–324; July, 1935.

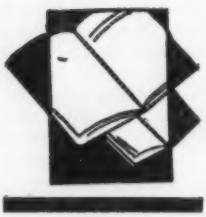
At the Central Y. M. C. A. College in Chicago two courses in introductory chemistry are given. One, consisting of three hours of lecture and four hours of laboratory per week, for one semester, is open to those who have had chemistry in high school. The other course, consisting of three hours of lecture and three hours of laboratory per week for two semesters is taken by those who have had no previous instruction in chemistry. A study of the marks received in the same course in qualitative analysis following these two introductory courses, reveals no large or significant difference between those who take the one-semester introductory course and those who take the two-semester course. —V.H.N.

RADIR, PAUL L. "Semiprofessional Courses in Zoology." *The Junior College Journal* 6: 26–27; October, 1935.

The author states that the "certificate" course in California junior colleges designed for pre-medical and pre-dental students is not suited for the needs "of the semi-professional students whose instruction must be sufficient to impart to him during a single semester a knowledge of the living world which will include: (a) a general concept of animal life; (b) an appreciation of the values, positive and negative of the various living forms; (c) an active interest in animate things which will function advantageously in the use of his leisure time." He therefore advocates that a considerable portion of the time be devoted to a study of local fauna through field trips and laboratory study in which emphasis is placed upon the study of skins, demonstrations with projection machine, micro-projector, charts and other visual equipment, and living animals. He further advocates that "the drawings should be limited to a few things wherein the student's originality of observation may be tested." The author also favors a two-hour rather than a three-hour laboratory period believing that the third hour is "Better spent in demonstration, discussion, or readings, and that the course should be enriched by special projects for gifted students. The author summarizes his opinions with these statements, "The suggestions brought forth here do not infer that the course shall be an easy one, catering to mediocrity. It should be replete with illustrative material which will have as its ultimate aim the enriching of the student's mind with a knowledge of the principles of structure, growth, and activities of animals in such a manner that he will build up a philosophy of the intricate interrelationship of all living creatures."

—F.D.C.

New publications



THORNDIKE, EDWARD L. *Adult Interests.* New York: The Macmillan Company, 1935. 265 p. $3.25.

The reader may conclude from this study that the psychology of learning (including interests) as applied to children and youths applies in much the same manner to adults. Interests change but new interests arise or old ones strengthen, as others wane. The intensity of interest remains about equal through childhood and adulthood. Furthermore the character of the interests may be at least in some measure controlled. Interests may be awakened and through the use of exercises in which they occur they may be strengthened. Undesirable interests are weakened by avoiding exercises in which they occur. Desirable activities, though unattractive, may be made attractive. The observations lead the investigator to conclude "that honest effort to act as if (a person) had an interest in a certain sort of learning will foster that interest to some extent and (one) may be confident that even if they do not increase interest they will facilitate learning."

One section of the report deals with "learning what is intrinsically uninteresting." The data here support a rather unexpected conclusion, namely, that intrinsic interest has but little effect on success in learning. This conclusion is based upon data showing a comparison of successes in learning birth years of celebrities in art, letters, etc., and successes in learning birth years of nonentities (tailors, cobblers, etc.); the real birth years of celebrities, and years stated to be years when they were not born; and other somewhat similar learning exercises. One may not conclude, however, that interests are not important in the learning process for the investigator concludes, "Interests exert a large fraction of their power in determining what shall satisfy and what shall annoy the learner."

Other features of the report include differences in interests and attitudes between young and old adults; inventories of adult likes and dislikes; individual differences; extending adult education; and methods of teaching adults. The character of the data and the methods by means of which the data were obtained are shown in appendices covering 90 pages.

Understanding of interests and attitudes, now so much discussed by science teachers, will be enlarged by the study of conclusions supported in this study.

This report on adult interests is based upon researches made possible by a grant from the Carnegie Corporation.

—S.R.P.

STRANG, RUTH. *The Rôle of the Teacher in Personnel Work.* New York: Bureau of Publications, Teachers College, Columbia University, 1935. 417 p. $2.50.

Emphasis is placed in this book upon the rôle of the teacher as guide. Part I, Individualization in Education, develops this point of view as a guiding philosophy; Part II, Student Adjustments, shows the need for guidance in adjustment problems of the student; and Part III, Technics in Personnel Work, discusses methods useful in guidance.

While the book is comprehensive, it covers the subject of guidance in easily readable and understandable language. One may read it without feeling any sense of weight or fatigue or doubt as to what the author means. It is clearly outlined and well written. It will be especially useful to the teacher who has not yet seen her rôle as primarily a guide to wise student activity.

—A.W.H.

FITZPATRICK, FREDERICK L. *Biology for Public School Administrators.* New York: Bureau of Publications, Teachers College, Columbia University, 1934. 96 p. $1.25.

One of a series of monographs written by subject-matter specialists on the faculty of Teachers College of Columbia University, this brief treatise outlines a philosophy of the high-school course in general biology, presents an outline of a course in general biology, considers what shall be an adequate background of courses for the teacher of biology, gives some suggestions concerning teaching procedures, discusses the biology classroom layout and the equipment and supplies for the course, and closes with a list of reference books and other sources of information.

"While the book has been written primarily for administrators, it necessarily deals with many topics which are of interest to biology teachers" (p. iii of Preface). It is really a series of recommendations relating to the administration of the general biology course in the high school and, as such, it should prove to be a valuable guide to both administrators and teachers.

The fifteen-page outline of a course in general biology, towards which are focussed the practical suggestions and recommendations, is arranged into seven unit topics, each analyzed into sub-topics and, under these, are stated the major principles and generalizations of the course followed by subdivisions in the form of topics. The general plan of outline is not always consistent and one has some difficulty in obtaining a clear-cut picture of the course.

The outline covers a wide area, planned to sketch the broad field of general biology and suggesting that there is enough content for more than one year's work. The time to be spent on the course will determine the depth of understanding to be attained in each aspect of biology given.

The discussion on teaching procedures in biology, covering only sixteen pages, merely touches upon guiding principles in terms of the author's philosophy. There is no attempt to professionalize the specific content of the course and little is said concerning the nature of the learning activities which are always the real measure of the value of a course. There are statements to the effect that the use of principles and generalizations as a basis of organization does not eliminate the possibility of following a unit plan of presentation but one does not find stated the generalizations or large ideas which are the units; rather the units are stated as comprehensive topics. —C.J.P.

PRUITT, CLARENCE MARTIN. *An Analysis, Evaluation and Synthesis of Subject-Matter Concepts and Generalization in Chemistry.* Colorado State College of Education, Greeley, Colorado: the author, 1935. 176 p.

After reviewing related studies that have been made, the author proceeds to state the results of the analysis of over 50,000 pages of books on sociology, popular books in science, high school and college textbooks both in chemistry and other science fields, non-scientific and scientific magazines, newspapers and examination questions in chemistry. The list of concepts and generalizations is given separately for each of these seventeen sources of materials. There is a final list of 135 generalizations arranged somewhat in order of importance as determined by frequency in the sources analyzed.

The whole study is a fine piece of work and should give a very clear notion of what needs to be taught in consumer chemistry. The bibliography listed 135 items and the summarizing review of it may be very welcome to those who may not be able to keep up with the increasing volume of literature in this field.

The author's interpretation of the study occupies four pages. It cannot be summarized for it is itself a summary. Perhaps this excerpt (p. 155) comes as near to stating the gist of the author's conclusions as anything that can be quoted. "This study would seem to offer positive justification for the inclusion (in the secondary chemistry course) of more material on foods, health, building material, and clothing. Such points would be emphasized as classes of food, food preservation, oxidation processes in the body, vitamins, hormones, enzymes, digestion, specific reactions of chemicals on cells of organisms, the carbon dioxide-oxygen cycle, drugs, glands, dyes, fibers used for clothing, metals and alloys, paper, common building materials, the electronic structure of matter, and the importance of heat, light, bacteria and catalysts as agents inducing chemical changes." —E.R.D.

DUNN, FANNIE W., Chairman. *Materials of Instruction.* New York: Bureau of Publications, Teachers College, Columbia University, 1935. 242 p. $2.00.

This is the eighth yearbook of the Department of Supervisors and Directors of Instruction of the National Education Association. It is the purpose of this yearbook "to stimulate thinking about the part which materials play in a program of education, and to offer practical helps to supervisors and teachers in the discovery, selection, and use of some of the more important types of instructional materials." To this end the Committee considers the following topics: the environment as a primary source of instructional materials; the service of books in extending the environment; aids for experiences in learning, such as field trips, specimens, models, pictures, lantern slides, motion pictures and films; instructional material for fine and practical arts; selection, organization, administration, and management of materials; and improvement of instructional materials by supervisors. An extended appendix contains annotated bibliographies of sources of supplementary teaching aids; lists of books for children; and studies of reading interests and activities of children.

Teachers and supervisors in science as well as in other fields will find this yearbook extremely helpful in bringing them great numbers of practical suggestions that are important in a program of education. —F.G.B.

YOAKAM, GERALD ALAN AND SIMPSON, ROBERT G. *Directed Study and Observation of Teaching.* New York: Macmillan, 1934. 234 p. $1.30.

This is a workbook to accompany the authors' *An Introduction to Teaching and Learning.* The course which it fits best is the college course in Introduction to Education. Much of the material falls within the general field most often spoken of as general methods. The workbook will be of greatest interest to college teachers of the college courses indicated.

The general plan includes a short introduction, sections on the activities and techniques of teaching, the activities and techniques of learning, the media of teaching and learning, and a final section on integrated learning activities. Topics

included under these major sections are classroom management, the assignment, lesson planning, questioning, directing study, diagnostic testing, remedial teaching, motor learning, associative learning, problem solving, and so on. The illustrative material is largely drawn from the elementary-school level. Prospective high-school teachers may not be highly interested in the development for this reason.

The workbook material consists of the following: a very brief introduction to the unit, a short list of paged references, study questions and problems, an observation exercise, a written report of the observation, and an "assimilation" test. This formula is repeated for each unit.

The book will find its greatest usefulness in the hands of teachers using the accompanying textbook. —R.K.W.

Hunter, George W., and Whitman, Walter G. *Laboratory Exercises for My Own Science Problems* (7th year). 168 p.; *Laboratory Exercises for Science in Our World of Progress* (9th year). 232 p. New York: American Book Company. 1935.

This series of workbooks has been written for use with the author's "March of Science" series of junior-high-school science textbooks. Different types of pupil activities are suggested which correlate directly with the texts.

—Elwood D. Heiss.

Fitzpatrick, Frederick L., and Horton, Ralph H. *Students Manual in Biology.* Boston: Houghton Mifflin Company, 1935. 155 p. $0.48.

This is a workbook to accompany *Biology* written by the same authors. It contains a variety of exercises in which the pupil is expected to answer questions based upon readings in his textbook or some other selected reference. A number of "cut-and-paste" drawings which the student is expected to reassemble are also included. —Elwood D. Heiss.

Holman, Richard M. and Robbins, Wilfred W. *A Textbook of General Botany for Colleges and Universities.* New York: John Wiley and Sons, 1934. 626 p. $4.00.

The third edition of this well-known textbook, like the predecessors in their time is an outstanding contribution to the field of botany. Without increasing the size of the book, except through the addition of some fifty new illustrations, portions of every chapter of the second edition have been rewritten and the newer developments in general botany have been incorporated. The use of fine print for statements of explanatory physical and chemical principles and for certain detailed and special material represents another change from the earlier edition and serves as an aid to students and teachers. The excellent list of references for collateral reading, given in an appendix, will serve to make this edition even more valuable.

As in the second edition, the book is designed for a year's course, Part I to be studied during the first half and Part II during the second half. However, Part I, which discusses the structure and physiology of seed-bearing plants, may be used alone as an introduction to general botany. Part II presents a survey of the plant kingdom with emphasis upon development, reproduction and relationships, including a final chapter on evolution and heredity.

Those of our readers who have studied or taught an earlier edition of this book will be delighted to read the revision and with oncoming college students will enjoy the book as a clear, masterful exposition of the principles of plant science. —C.J.P.

Kilpatrick, William Heard. *A Reconstructed Theory of the Educative Process.* New York: Bureau of Publications, Teachers College, Columbia University, 1935. 30 p. $0.25.

This pamphlet is a reprint of an article by Professor Kilpatrick in the issue of the *Teachers College Record* for March, 1931, and revised in January of 1935. It is a summary of a philosophy of education to fit a changing world and is based upon newer developments in the field of the natural sciences.

The essential thesis is, "education is life itself." This is elaborated as follows. "Our task as educators is to begin with life, to nurse it, to help it to grow, to help it enrich itself, always so that more of life may result in the person himself and in all whom he touches. There is no richness but life itself." . . . "Education is the process of building self by guiding and enriching life so that more life ensues."

Two concepts may have important consequences. One is the proposal that the environment cannot be separated from the individual organism. The other is that the subject matter or stuff of the curriculum cannot be separated from learning. "In this way subject matter ceases to be thought of as named in advance of the situation."

Some of the material would seem to consist of statements of philosophical platitudes. There are no illustrations of how the implications of the philosophy might effect practical school or home situations. The working out of such applications is left to the reader.

Such discussion is stimulating as a means for keeping the professional educator from becoming bound by the traditions of his craft. On the other hand, the reader is urged to look for implications and to make the attempt to determine where the ramifications of the proposed philosophy may lead in actual practice. —R.K.W.

Patch, Edith M. *Holiday Hill.* New York: The Macmillan Company, 1935. 135 p. $0.96.

This is a reissue of a popular book in elementary science which was first published in 1931. (See October, 1932, issue of Science Education for the former review of "Holiday Hill"). Wide

usage attests to the fact that elementary science teachers have found it suitable to their needs.

—June Common.

HUMPHREYS, W. J. *Weather Proverbs and Paradoxes.* Baltimore: The Williams and Wilkins Company, 1934. 126 p. $2.00.

This is the second edition of a book first printed in 1923. Doctor Humphreys is a meteorological physicist of the United States Weather Bureau and the author of *Physics of the Air, Rainmaking and Other Weather Vagaries,* and *Fogs and Clouds.* Part I discusses Weather Proverbs, pointing out those weather sayings that have a scientific basis of fact based on physical causes and those that are mere superstitions or absurdities. Part II discusses Meteorological Paradoxes. This is a very interesting section. A few of the paradoxes discussed are: As the nights grow longer, the heat grows stronger. The nearer the sun, the colder the air; To cool air, heat it; The hotter the sun, the colder the earth; The sun rises before it is up; The sun sets after it is down.

To those who desire to know the weather and be able to predict the weather by the reading of signs, this book will be of particular practical usefulness. General science teachers will find it excellent supplementary reading for their weather unit. —C.M.P.

MORGAN, JOHN J. B. *Keeping a Sound Body.* New York: The Macmillan Company, 1934. 440 p. $2.00.

This is fundamentally a book on practical psychology and mental hygiene. In the preface the author states that "the point of view which underlies the content of this book is that mental health is dependent upon the formation of certain mental habits and the elimination of others."

The absence of technical language and the wealth of illustrations and concrete suggestions makes this a most readable treatise. The author maintains that the book presents "no arm-chair theories, nor do they represent the pet hobbies of the writer nor the biased viewpoint of some partisan in the field." An indication of the content of the book may be gained from the chapter headings: How to Evaluate Your Mental Health; Mental Conflicts; The Mastery of Fear; What to Fight For; How to Fight; Emotional Maturity; Correct Thinking; Counteracting Defects; Exaggerating Defects; Crime; Overcoming Emotional Depressions; How to Get Things Done; Getting Along With People; and Self-Confidence. —C.M.P.

WOODRING, MAXIE NAVE AND FEMMING, CECILE WHITE. *Directing Study of High School Pupils.* New York: Bureau of Publications, Teachers College, Columbia University, 1935. 253 p. $2.50.

This is a reprint of articles from *Teachers College Record,* including an article in the October, 1935, number. To those science teachers who have felt the need of developing better study habits in their students, this book will prove an excellent source book. Attention is paid to certain aspects of directing learning more effectively, but the major problem of how to concretely apply the laws of learning and the findings of psychology to specific learning situations in science (as well as most secondary subjects) has as yet only a meager beginning. A wide gap still remains between what we have labelled as laws of learning and their practical application in the science classroom.

Some of the chapter headings are as follows: Problems in Directing Study of High School Pupils; A Survey of Investigations on Study; Diagnosis as a Basis for the Direction of Study; Directing Study Through the Assignment; Training High School Pupils in Study Procedures with Emphasis on Reading; The Library and the Study Problem; Remedial Instruction as an Aid to Effective Study; The Use of the Interview in the Improvement of Study; A Bibliography on Study; and Recent Trends in Study.

—C.M.P.

EISENBERG, ARTHUR A. AND HUNTLY, MABLE F. *Principles of Bacteriology,* St. Louis; The C. V. Mosby Company, 1935. 378. $2.75.

The present revision of this valuable work contains much entirely new material. Of special interest is the material on animal parasites, hypersensitiveness, allergy, food and drug idiosyncrasies. The rôle of the leucocytes is presented from the viewpoint of Shilling's hemogram. Many slight changes have been necessary to bring the entire book into line with present day knowledge. Students interested in bacteriology will find this volume a worthwhile addition to their library. There are 90 illustrations and 8 splendid color plates. —W.G.W.

TURNER, CLAIRE E. *Personal and Community Health.* St. Louis: C. V. Mosby Company, 1935. 680 p. $3.00. $0.35.

This is a text for college and university men and women. It gives a brief foundation of anatomy and physiology upon which it proceeds to build the essential present-day knowledge of personal and community hygiene. Under personal health we find: nutrition, digestion, oral hygiene, respiration, circulation, excretion, the skin, endocrines, the sense organs, nervous system, mental hygiene, body mechanics, foot hygiene, reproduction, heredity and health, narcotics and stimulants. Under community health we find, science of disease, prevention, communicable diseases, immunity, three great plagues, food control, water supply, waste disposal, ventilation, heating and lighting, public health administration, maternal and child hygiene, school hygiene, industrial hygiene, control of communicable diseases, disinfection and disinfectants. There is a glossary and 131 illustrations in addition to four color plates. —W.G.W.

Zoethout, Wm. D. *A Textbook of Physiology.* St. Louis: The C. V. Mosby Company, 1935. 694 p. $4.00.

This college text is suitable for students in dental, pharmacy and teachers colleges as well as in liberal arts colleges. This latest edition presents much new material particularly on hormones, vitamins, muscle physiology, and nervous system. The chapter titles are: protoplasm, ferments or enzymes, tissues, translocation of materials, muscle physiology, interrelationship of the organs, nerve physiology, blood, circulation of the blood, heart, vasomotor control, capillaries and lymph, gas exchange, foods, digestion, absorption, alimentary canal, protein metabolism, carbohydrate and fat metabolism, water and mineral metabolism, diet, vitamins, hormones, body temperature, renal secretion, skin, sense organs, reflex actions, brain, reproduction. There is a glossary. The book is illustrated by 271 line cuts or half-tones.

—W.G.W.

Zoethout, W. D. *Laboratory Experiments in Physiology.* St. Louis, Missouri: The C. V. Mosby Company, 1934. 256 p. $2.25.

The laboratory guide is the result of years of teaching and especially planned to accompany the author's text. Some experiments deal with the physical and chemical aspects of physiology as well as the major chemical processes occurring in the body.

The manual is valuable as a guide in learning because problematic situations are set up in each experiment, the directions are clear, and concise, and questions are designated which will direct the student's observation and summarization. Also, the included pictures and diagrams serve as aids in learning in that they both give information, guide observation and suggest laboratory techniques.

Only the minimum amounts of laboratory equipment are necessary for the listed experiments.

The laboratory manual is commendable because the author has definitely arranged the experiments in terms of learning exercises.

—Edith M. Selberg.

Hausmann, Erich and Slack, Edgar P. *Physics.* New York: D. Van Nostrand Company Inc., 1935. 776 p. $4.00.

This college text covers the fundamental principles of mechanics, heat, electricity and magnetism, sound and light. It is a one-year course. The more advanced sections are starred and may be omitted for shorter courses. The text offers a well-grounded foundation regardless of the future work of the student, whether he will major in science, engineering or pursue cultural courses. There are some 250 problems whose answers are given at the back of the book. There are 471 illustrations. The book is well made and attractive in appearance. —W.G.W.

Stetson, Harlan True. *Earth, Radio and the Stars.* New York: McGraw-Hill Book Company, 1934. 326 p. $3.00.

Teachers will find in this book fascinating material with which to illustrate the scientist's method of solving his problems. The descriptions of Professor Stetson's researches in attempts to determine relationships between variations in radio reception and the positions of sun and moon are interestingly told and clearly illustrate the various steps in analyzing data, formulating hypotheses and checking them. The breakdown of the boundaries between the sciences which has been going on so rapidly of late is also well illustrated. Cosmic rays, radio reception, electrical characteristics of the atmosphere, terrestrial magnetism, astronomical observation, and even geology and biology became inextricably entangled. The earlier chapters review the more fundamental astronomical facts concerning the moving earth. Chapters III, V, and VI deal with the author's investigations regarding the stability of the earth and the moon as a cause of changing latitude. The later chapters deal with the effect of sun and moon on atmospheric conditions which affect radio reception. The chapters are titled as follows: The Twin Planet, The Wandering Poles, Does the Moon Change the Latitude? Ocean Tides, Earth Tides, Variation in Longitude, The Earth from the Inside, The Sun's Effect on Human Affairs, Sun-Spots and Radio Reception, The Sun and the Ionized Layer, Transatlantic Radio Transmission, The Moon and Radio, Solar Eclipses and Radio, Meteors and Radio, Radio and the Stars, Illuminations in the Night Sky, Cosmic Clouds, Cosmic Rays, Cosmecology. There is an extensive bibliography.

—O. E. Underhill.

Brown, William H. *The Plant Kingdom.* Boston: Ginn and Company, 1935. 850 p. $3.50.

This is a textbook of general botany on the college level. The first sixteen chapters deal with the morphology and physiology of leaf, stem, root, flower, fruit and seed, and include chapters on the cell and heredity. Thirteen chapters follow which discuss the various plant divisions giving one chapter to bacteria, six chapters to algae (including flagellates) two chapters to Fungi (including slime molds) and a chapter each to mosses, ferns, and seed plants. The development of reproduction in the algae is more clearly brought out through the use of a variety of species as illustrations than is usual in the traditional treatment which depends on Protoccus, Ulothrix, Spirogira, Oedogonium and Vaucheria as the types by which to make clear the evolutional development. The two closing chapters are on palebotany and evolution, the latter chapter summing up briefly the implications of the material presented in the previous fifteen chapters regarding the comparative anatomy of the progressively increasing complexity of plant forms. The book

is copiously illustrated and every illustration seems to be especially apt and useful.

—O. E. Underhill.

RICE, EDWARD LORANS. *An Introduction to Biology.* Boston: Ginn and Company, 1935. 602 p. $3.20.

This book is designed for use as a text in introductory general biology courses for students who wish to continue with advanced study as well as for those who will not continue work in the biological field.

The author presents the study of animals by means of representative types or samplings. More complete discussions are given of man and frog with which he compares other forms of animal life emphasizing the unity of life processes of animals. A few types of plants are discussed with emphasis given to similarities in their life processes. The main theme of the book is the essential unity of all life which leads to the theory of evolution as the underlying principle explaining this unity. —F.G.B.

SMITH, JEANNETTE. *A Summer By the Sea.* New York: American Book Company, 1935. 135 p. $0.52.

A very pleasing little book describing what is seen by a group of children summering at Virginia Beach. The sketches which adorn its pages recall faithfully scenes which the reviewer has often seen in many visits throughout the Cape Henry region.

With the exception of the first few pages, which smack too much of the didactic manner of Mrs. Barbauld and Maria Edgworth of a century and more ago, the narrative runs along easily, describing crab, snail, sand dune, lighthouse, oyster farming and other objects and activities associated with a beach community. The author does not stop with mere description, however, but skillfully uses her materials to make meaningful the experiences related through the medium of Tom, Mary, Anne, Aunt May, Uncle John and the others. The book should serve well as supplementary reading for about the third or fourth grade. It is one of the best of the recent nature readers. —O. E. Underhill.

NICOL, LUCILLE, LEVENSON, SAMUEL M. AND KAHN, TERESSA. *The Nature Hour:* Fifth Year-Spring, 114 p. Fifth Year-Autumn and Winter, 118 p. $0.76 each. Sixth Year-Spring, 133 p. Sixth Year-Autumn and Winter, 132 p. $0.80 each. Newark, N. J.: Silver Burdett and Company, 1935.

Each volume has six chapters. Each of the first five chapters contains reading material about various animals and plants mostly, with occasional discussion of some astronomical material. Each chapter also contains nature poems, activities and self tests. The sixth chapter in each volume is given to suggestions of materials for special occasions such as Arbor Day or Humane Week, suggestions for clubs, and other activities.

—O. E. Underhill.

PATCH, EDITH M. AND HOWE, HARRISON E. *Nature and Science Series, Book VI: The Work of Scientists.* New York: The Mcmillan Company, 1935. 488 p. $0.76.

In this book the authors introduce their young readers to the work of great scientists in the field of astronomy, geology, meteorology, biology, and physics. They show the intimate association of the work of scientists with the development of industry and art by telling how different kinds of pictures are made; how glass making developed; how common metals are derived; the way in which rubber is prepared; and the relation of science to the present methods of transportation.

The style is dignified and direct; the print is large; and the cover is attractive. The book is well illustrated by drawings in black and white. At the close of each section is a list of interesting activities designed to extend the study of the topic considered in the unit. References relating to the various topics discussed are given at the close of the book.

This book will interest children on fifth- and sixth-grade levels either as a science reader or as a library book. —F.G.B.

BOYD, T. A. *Research, The Pathfinder of Science and Industry.* New York: D. Appleton-Century Company, 1935. 319 p. $2.50.

The author is a member of the staff of the Research Division of General Motors. His particular work has been as chief of the Fuel Section of this division of General Motors.

The book is descriptive of the work carried on by large research organizations, especially those supported by large industrial concerns. The reader will be able to gain a much clearer insight into the work done by modern research technicians. The book is quite attractively written and easily read by the layman. Although much of the description is developed by illustrations drawn from various research fields, there are almost no technicalities to interfere with the interpretation of the reader not trained in science. On the other hand the trained scientists may well consider the definition of research and the descriptions of the methods of research.

Part one is concerned with a definition of research and a discussion of differences between pure and applied research. Part two deals with methods. The reviewer is pleased to find here treated a group of methods rather than *a scientific method.* Part three presents the types of personalities of the men doing research. Four deals with qualifications needed by the would be researcher. Part four is concerned with the effects and results of research when it is achieved. In part six are to be found certain additions such as by-products of research, renumeration, and the penalties of pioneering.

There is an excellent bibliography of other material dealing with research at the end.

The book is recommended to all high school and college students with serious interests in the field of science. High school and college teachers of science should read the volume. Any lay-

man with a thoughtful concern about our modern industrial world should be able to find here a profitable and entertaining way to spend several pleasant hours. —R.K.W.

Lehmann, Herbert G. *Shop Projects in Electricity.* New York: American Book Company, 1935. 182 p. $0.96.

This book should prove of great help to teachers of physics and general science. The projects range from the construction of such simple apparatus as a jelly-glass dry cell, galvanometer, and telegraph system to the construction of a serviceable transformer or a 110-volt synchronous motor. One of the more useful constructions is a 110-volt safety switchboard which by means of bulbs and heater elements enables one to connect these in series or parallel for obtaining low or high amperage, at the same time avoiding any danger from an accidental short circuit. There are 21 projects in all. Materials required for each construction are listed and the directions are simple and adequate. Each construction is followed by a series of questions, followed by the answers. Following the directions for the projects is a "theoretical section" of twenty-two pages which discusses the simple physics underlying each. —O. E. Underhill.

Regenstein, Anna B. and Teeters, Wm. Ray. *Science at Work.* New York: Rand McNally and Company, 1935. 628 p. $1.68.

This is a ninth-grade text in general science. The book is not a revision of the earlier *General Science* of the same authors, although the content is much the same. The book is a new book with a different type of organization. In the opinion of the reviewer, the new book is superior in organization to the older one.

The organization of this book is the unit and "problem" type of organization. The authors have done the unconventional in frankly stating the purposes of the book in specifically numbered statements in the preface.

The formula of organization is as follows: A unit number and title, a preview, a statement of problems for the unit, the text material following the order of the problems, laboratory activities, summarizing activities, investigating activities, and references for reading.

Laboratory activities are put at the end of units rather than being scattered through the reading. These exercises are being scattered through the reading. These exercises are complete and well illustrated with simple diagrams. The summarizing activities are in the form of short tests.

Many applications of science are treated. These should be of concern and interest to the ninth grade pupil. In places there seem to be some rather technical physics and chemistry for pupils with little or no background in the sciences.

The book is recommended to the careful consideration of general science teachers looking for a new text. —R.K.W.

Yoakam, G. A. and Simpson, R. G. *An Introduction to Teaching and Learning.* New York: The Macmillan Company, 1934. 498 p. $2.50.

This book is a text in general methods. Other terms for the field covered are principles of teaching, or technique of teaching. Although the principles are generalized, the illustrative materials are drawn largely from elementary school situations. Therefore, the book is better adapted to the needs of elementary school teachers than those of secondary teachers.

One of the authors is professor of elementary education at the University of Pittsburgh. The other is professor of education and psychology at the Carnegie Institute of Technology.

Part I presents the function of the teacher and certain basic principles concerning the nature of learning. Part II deals with such practical activities of the teacher as management, lesson planning, assigning lessons, questioning, remedial teaching, diagnosis, and testing and examining. Part II deals with various types of learning such as, observational learning, motor learning, problem solving, creative learning, *et al.* Part IV deals with teaching and learning media, *i.e.*, methods. Part V deals with integrated teaching and learning activities. In this, various types of learning activities and kinds of learning units are discussed.

Teachers in teacher-trainging institutions will be concerned with this volume as a possible text. Teachers in service wishing to bring their thinking in line with recent developments in methodology may well read it with profit.

—R.K.W.

Leining, Edna Bridge. *Millions of Years in a Winter.* New York: Bureau of Publication, Teachers College, Columbia University, 1935. 197 p. $2.00.

This book shows how the field of science can be utilized as a source of curriculum material in the elementary school. *Millions of Years in a Winter* is a fourth grade study carried on at the Lincoln School of Teachers College, a study of the origin of the earth in the universe and the use of earth material.

A teacher's diary is given as a record of the unit, followed by the teacher's interpretation of the problems and values of the unit, other aspects of the educative experiment, copies of the tests used with results, and suggested bibliography. These are given in sufficient detail to make the study of distinct value to the elementary-school teacher and the curriculum maker. The book is well written and attractively illustrated.

—Lois M. Shoemaker.